Νυμφαίο

Αρ. 147 – ΦΕΒΡΟΥΑΡΙΟΣ 2021

ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ & ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ

Τα Νέα της Ε Ε Ε Ε Γ Μ

147

Ανάληψη Διοργάνωσης World Tunnel Congress 2023 (WTC2023) της ITA-AITES από την Ελληνική Επιτροπή Σηράγγων & Υπογείων Έργων

Αγαπητοί Συνάδελφοι

Η Ελληνική Επιτροπή Σηράγγων και Υπογείων Έργων βρίσκεται στην ευχάριστη θέση να ανακοινώσει ότι, κατόπιν ψηφοφορίας στη Γενική Συνέλευση της Διεθνούς Ένωσης Σηράγγων & Υπογείων Έργων, ανέλαβε τη διοργάνωση του **World Tunnel Congress 2023 (WTC2023)**.

Η επικράτηση της υποψηφιότητας της ΕΕΣΥΕ στην μυστική ψηφοφορία που συμμετείχαν 47 κράτη μέλη της ITA-AITES ήταν καθολική. Η ΕΕΣΥΕ έλαβε 33 ψήφους (ποσοστό 70%), έναντι της έτερης Τουρκικής Υποψηφιότητας που έλαβε 14 ψήφους (ποσοστό 30%).

Το παγκόσμιο συνέδριο WTC2023 αποτελεί ετησίως την κορυφαία διοργάνωση της Διεθνούς Ένωσης Σηράγγων & Υπογείων Έργων (International Tunnelling and Underground Space Association, ITA - AITES). Οι συμμετοχές

(συνέχεια στην σελίδα 3)

Π Ε Ρ Ι Ε Χ Ο Μ Ε Ν Α

(συνέχεια από 1η σελίδα)

στο συνέδριο ξεπερνούν τους 2000 συνέδρους που προέρχονται από όλον τον κόσμο, ενώ περιλαμβάνει επίσης μεγάλη Τεχνική Έκθεση όπου συμμετέχουν συστηματικά οι μεγαλύτερες, παγκοσμίως, εταιρίες που δραστηριοποιούνται στον τομέα μελέτης, κατασκευής, λειτουργίας και συντήρησης σηράγγων και υπογείων έργων (κατασκευαστικές, μελετητικές, μηχανημάτων, εξοπλισμού, υλικών, λογισμικού κτλ).

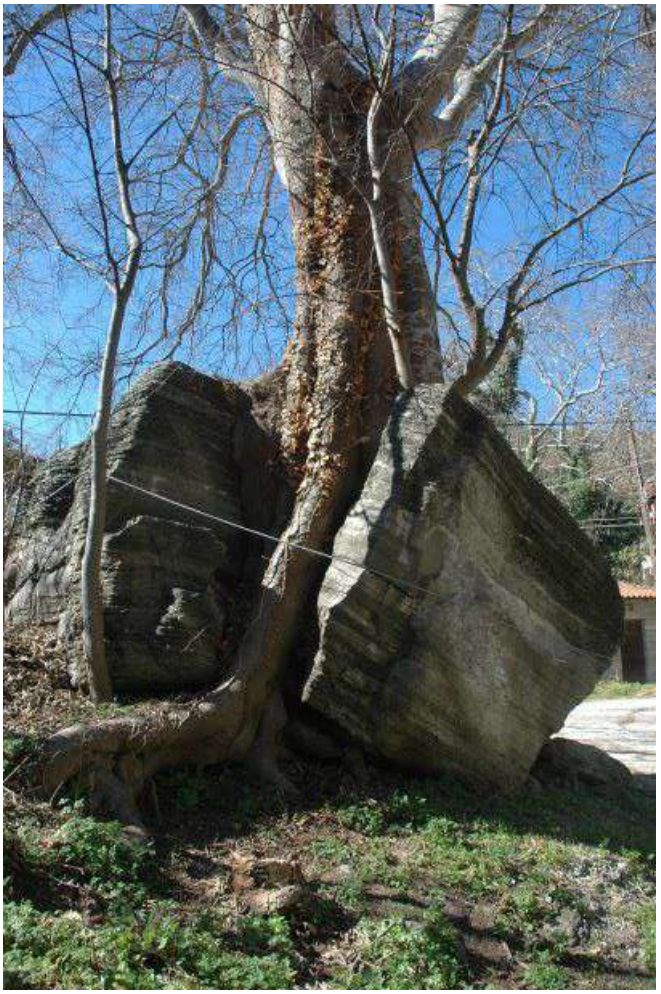
Πρόκειται για το μεγαλύτερο διεθνές συνέδριο του Τεχνικού Κλάδου που έχει αναληφθεί ποτέ από τη χώρα μας. Ευελπιστούμε ότι μέχρι τότε θα έχουμε ξεπεράσει εντελώς τις δυσκολίες που έχει προκαλέσει η πανδημία COVID-19 και ότι θα καταφέρουμε να διοργανώσουμε ένα πολύ επιτυχημένο συνέδριο με φυσική παρουσία.

Η προετοιμασία της διοργάνωσης που ξεκίνησε μόλις σήμερα και θα διαρκέσει για τους επόμενους 27 μήνες θα απαιτήσει πάρα πολλή δουλειά σε πολλά επίπεδα.

Σας προσκαλούμε να συμμετάσχετε για να επιδείξουμε το υψηλό επιστημονικό επίπεδο των μελών της επιτροπής μας, αλλά και την Ελληνική φιλοξενία.

Για το Δ.Σ. της ΕΕΣΥΕ

Γιάννης Φίκιρης
Πρόεδρος Ελληνικής Επιτροπής Σηράγγων & Υπογείων Έργων



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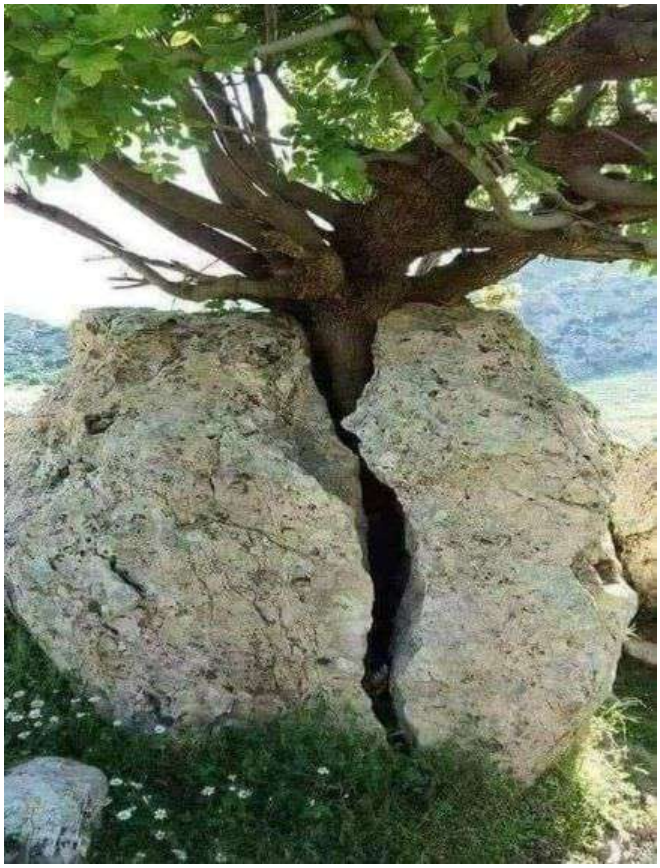

Ageing Dams Pose Growing Threat

Στο προηγούμενο τεύχος του περιοδικού (Αρ. 146, Ιανουαρίου 2021) δημοσιεύσαμε άρθρο αναφερόμενο στην έκθεση του UNU Institute for Water, Environment and Health (UNU-INWEH) "**Ageing Water Infrastructure: An Emerging Global Risk**", καθώς και στοιχεία της έκθεσης.

Την έκθεση σχολίασε ο Michael F. Rogers, Πρόεδρος της International Commision on Large Dams με την ακόλουθη επιστολή του:

Michael F. Rogers, PE, P.Eng, PMP
President of ICOLD
Indianapolis, Indiana USA

February 2, 2021

Dr. Michael Small, Chair
International Advisory Committee
United Nations University – Institute for Water, Environment and Health
204-175 Longwood RD S
Hamilton, ON L8P 0A1 CANADA

Subject: **Comments on recent United Nations University publication, *Ageing Water Storage Infrastructure: An Emerging Global Risk.***

Dear Dr. Small,

Introducing myself as President of the International Commission on Large Dams (ICOLD), the world's preeminent professional organization for dams and dam safety. I have been an active practitioner of civil engineering for the design and construction of dams for more than 40 years. Please find hereafter, my comments on the recent publication *Ageing Water Storage Infrastructure: An Emerging Global Risk* attributed to the United Nations University Institute for Water, Environment and Health (UNU-INWEH), 2021.

I appreciate the efforts of the authors to contribute to the discussion of the importance of maintaining global infrastructure, especially the critical function of dams and hydropower in modern society. However, "aging" infrastructure, as characterized in this article and although a familiar soundbite, does a disservice to the real challenges and the benefits of dams in society, and thus the discussions our societies should be having on this important topic. As such, I am concerned that the article will not meet the desired intent to progress the discussion on the management of risks associated with dams.

I believe that the authors of this article attempt to directly link dam risk with decommissioning and removal, as evidenced by the lack of mention regarding the societal benefits of dams. Dams stand head-and-shoulders above all other renewable energy sources by providing society with more than just clean renewable hydropower energy. They can also provide reliable water supplies, flood control, recreation, and an adaptation to climate change like no other renewable with the ability to store water and energy; and not just while the sun shines and the wind blows.

As a representative of our industry, ICOLD has been studying and documenting the state of the practice of dam engineering for more than 90 years. As President, I can relate to you that our industry would characterize the most significant challenges to dams as:

- A rapidly changing natural world that both threatens to make natural events such as floods and earthquakes more frequent and intense, while at the same time placing more demand on those key societal benefits that dams offer such as clean water and clean power.
- Infrastructure which was designed and constructed with the science and engineering of decades past that now require an infusion of investment to address the advancements in our profession for safety and reliability.
- A fundamental disconnect in society regarding the how land development behavior has privatized gains in and around dams, while socializing the losses and risks that invariably come with increasing populations.

So, I submit that the authors have missed the point and that the challenge is not really aging of dams. Engineering design and construction of dams must be appreciated for its robust nature intrinsic for generations in practice and regulation. Dams are designed, built, carefully supervised, and maintained as an ever indispensable, vital part of our society's critical infrastructure. Careful regulation and a strong professsional state of the practice built on global cooperation through ICOLD have shown that dam structures can have a life expectancy of hundreds to thousands of years.

ICOLD exists to facilitate sharing of knowledge and experience so that dams are designed and built with a strong focus on meeting design intent with consideration for resiliency and sustainability for the future. One need only look at the Roman dam near Extremadura, Spain, Proserpina Dam which was commissioned back in the 1st century AD. It was built to provide water supply to the city of Emerita Augusta. This dam has lasted more than 2000 years serving as a key part of the regional infrastructure to provide clean water to the local residents. It shows that with proper engineering, good construction and regular maintenance, the dams that we design and build today can continue to serve people of our world for many, many generations.

It is inaccurate and a gross misunderstanding of the technology of dam design to describe the average life expectancy of a dam is to last 50-100 years as represented in the article. Modern high hazard dams have been designed for extreme events such as "probable maximum" flood and "maximum credible" earthquakes, events which have a probability of one in thousands of years. ICOLD has been a driving force for global cooperation and collaboration in dam safety through publications and regular technical seminars and training. More than just a repository of the World Registry of Dams (WRD) referenced in the UNU-INWEH article, the 104 countries of ICOLD – a United Nations of dam engineering – brings together knowledge and experience without regard to political or geographic boundaries. Through ICOLD's publications of experience and guidelines, the world's population is better served by those in the profession of dam engineering committed to excellence and safety.

ICOLD's recent World Declaration on Dam Safety reaffirms our industry's commitment to the safe development of dams around the world. The World Declaration touches different areas, including ICOLD's long-term mission and commitment to dam safety considering the changing conditions of dam safety around the world. The declaration addresses the important aspects of dam safety, including structural integrity, surveillance and monitoring, instrumentation, and basic design, and discusses what it means to have a successful dam safety program.

A critical statement in the ICOLD World Declaration is that for the hundreds of thousands of dams of all sizes around the world, we must all do our part in managing risks: owners must take full responsibility for their projects with a regular and routine safety assessments; Governments must also do their part to protect those at risk with strong governance and oversight; and communities must plan and develop land around critical infrastructure in a responsible and sustainable manner.

The continued use of dams of all sizes must be weighed against their ability to continue to serve a useful purpose related to their design intent and risks for continued operations. Our industry considers decommissioning of dams in context as just one of many risk management strategies, but certainly not the sole means or even primary means of addressing risks as implied in the article. The cost of dam removal is influenced by many site-specific factors, including treatment of accumulated reservoir sediments, stream restoration, and loss of operational benefits (flood control, water supply, power, recreation, etc.). While there are certainly exceptions, in general the experience of our industry has been that regular refurbishment and good upkeep will be less expensive than dam removal, and more beneficial to society. When these critical risk management decisions are made on dams, multiple criteria are considered, not just economics. Chief among the decision objectives are public safety and the co-equal goals of the environment.

Instead of ageing of water storage infrastructure, the largest "emerging" risk factor should be the increase in unregulated downstream development without consideration of the corresponding risk escalation. Society has been quick to "privatize development gains and socialize development risks". That is, profits from flood plain development are kept by the developers, while damages from developing in known flood risk areas are left to insurances and government reimbursement of losses.

There are many strong advocates for increasing safety related investment in dams. For example, the World Bank in just the last few years has invested over a billion US$ in the Dam Rehabilitation Improvement Program (DRIP) in India. More investment like this is needed around the world, especially in those countries like the United States where recognized lack of investment in critical infrastructure has been documented by the American Society of Civil Engineers (ASCE) and others for decades. Unfortunately, only when a bridge collapses; a power grid shuts down; or a dam spillway erodes does the proper (but short-lived) attention be brought to bear on the systemic problems.

I applaud the UNU-INWEH for this publication – any publication – that brings a light to infrastructure challenges of our generation. We should be reminded that "We are made wise not by the recollection of our past, but by the responsibility for our future." (George Bernard Shaw). We owe it to the next generations to take care of what has been given to us so that they may have similar opportunities for success. In a society focused on "green" sustainability, more recognition is needed of the benefits of carbon-clean and renewable hydropower as the world's largest and most viable market for clean power and water for developed and developing countries and people on our planet. Water is a renewable resource in the hydrologic cycle powered by strong cosmic features – sun, wind, and gravity – that sustains our planet. A strong four-legged chair of water, sun, wind, and gravity can support a growing global population using the experience gained in a history of good and tragic lessons learned.

Nothing – not man nor grandest feat of man's ingenuity – can escape the rigors of time. As stated in the UNU-INWEH article, it is agreeable that "value judgements will determine the fate of many of these large water storage structures." These value judgements, however, must be informed by science and not passions to remove these silent protectors and servants of citizens in our modern society. Dams should not be damned for their age or environmental stigma. Science and technology demonstrate that water can work with solar, wind and gravity forces to create a sustainable and environmentally friendly service to meet the basic needs of humankind around the world for clean and reliable sources of water and power, along with the protections of flood control and many other benefits.

In summary, "Ageing" is not an emerging risk in the profession of dam engineers. Rather, it is a long-held, well-documented and understood element of risk that is considered in the design and construction of dams of all sizes. I invite your representatives to participate in broadening the conversation addressed in the subject article by attending and engaging our profession at our next Congress in Marseille, France in November to recognize the hard work and progress already made in solving these challenges. We *are* paying attention to this risk and would welcome your help and contributions. As a representative of the profession, ICOLD remains committed to this vision of Better Dams for a Better World.

Sincerely,

Michael F. Rogers

President, International Commission on Large Dams / Commission Internationale des Grands Barrages (ICOLD/ CIGB)

Cc: Duminda Perera, Vladimir Smakhtin, Spencer Williams, Taylor North, Allen Curry (via contact.inweh@unu.edu)

Επί του ιδίου θέματος ο Michael Rogers έκανε την ακόλουθη ανάρτηση στο LinkedIn:

As ICOLD President I felt a responsibility to address the recent United Nations University publication, "Ageing Water Storage Infrastructure: An Emerging Global Risk." I appreciate the efforts of the authors to contribute to the discussion of the importance of maintaining global infrastructure, especially the critical function of dams and hydropower in modern society. However, "aging" infrastructure, as characterized in this article and although a familiar soundbite, does a disservice to the real challenges and the benefits of dams in society, and thus the discussions our societies should be having on this important topic.

Michael Rogers, PE, P.Eng, PMP • 2nd Stantec Global Dams Practice Leader / President of ICOLD / CIGB (International Commission on Large Dams)

ΑΡΘΡΑ

Practical Numerical Modelling – Lessons from Ancient Greece

At the upcoming Rocscience International Conference 2021 from April 20-21, a panel of experts will debate an important topic – the appropriate use of numerical modelling in geotechnical practice. The panellists will share differing perspectives, and the audience will enrich the discussion, curated by a moderator, by asking questions or contributing thoughts.

To allow conference participants to know some of the opinions ahead of time and prepare for the discussion, the panellists' positions will be posted on the conference website before the discussion date. Conference registrants can even send in questions or contributions before the start, and we will strive to share as many of them as possible during the discussion. As we prepare for April, we would like to share some food for thought on numerical modelling to prepare us for the day.

Models - their Purposes

As we know, models are simplified representations of real-world systems intended to help us understand the systems. Models are founded on relevant theory and knowledge and simplifying assumptions.

Building a model helps engineers to understand the problem they are trying to solve. It also allows us to identify how various factors combine to influence the behaviour of the system. We also use modelling tools to help us organize information on our problems and predict the system's future behaviours under different inputs or conditions.

Today, engineers do most of their modelling with computer software. It is one of their most powerful tools for deepening their understanding of geotechnical problems, fixing them, or improving designs. In theory, numerical modelling can handle a broad range of geotechnical problems. Troubles begin when they are employed blindly.

Limitations in Models

Modelling ALWAYS excludes specific details of the real-world. The critical question is what level of detail to include or exclude. If we exclude essential information, we risk making the model too simplistic, which will not deepen our understanding. On the other hand, if we include too much detail, the model becomes too complicated, time- and resource-consuming. As Michael Levitt, professor of structural biology at Stanford University (co-winner of the 2013 Nobel Prize for chemistry, explained in a Nature article) that **"The art is to find an approximation simple enough to be computable, but not so simple that you lose the useful detail."**

The limitations and errors in geotechnical models arise from the following:

1. Simplification of actual problems (e.g., excavation geometries) when building numerical models

2. Approximations and idealizations made in the development of the governing equations

3. Assumptions on the nature and behaviour of geological materials (e.g., the postulation that a rock mass, which comprises intact rock and discontinuities, can be represented with a continuum), and

4. Uncertainties in the values and distribution of input parameters (e.g., the variability of strength properties in space and uncertainty in scaling parameters from laboratory-size testing to the field.)

These errors and limitations of models likely led the statistician, George Box, to state that **"all models are wrong, but some are useful."** Good models improve insight into geotechnical excavations and structures' behaviour and help experienced engineers develop suitable mitigating measures.

Significant modelling problems arise when engineers frame questions incorrectly and mischaracterize problems. These errors are the most dangerous because they leave the real problem unaddressed, waste resources, and impede learning. Users of numerical modelling need significant knowledge and experience to avoid such misuse and abuse.

Healthy Skepticism – a Critical Skill for Engineering Modelling

Geotechnical engineers acquire essential knowledge such as engineering mechanics, CAD and numerical methods during their education, and practical technical skills on the job. However, one critical skill is often omitted – healthy skepticism towards their work and those of others. In modelling, this skill is indispensable. Without it, engineers are likely to be swayed by the seductive beauty of computer-generated graphics and the attractiveness of other modelling outcomes. Modellers must always judge results against observations, experience, and engineering judgment.

Misuse and Abuse of Numerical Modelling

We will now discuss a few typical instances of ways in which engineers and management misuse or abuse models.

The Illusion of Accurate Predictions

In our opinion, one of the most counterproductive aspects of numerical modelling in geotechnical engineering is the illusion of accurate predictions. Some specialists argue that given the large uncertainties and sometimes crude approximations in numerical models, geotechnical engineers are much better off providing order of magnitude predictions than offering "accurate" predictions. These often end up at the centre of debates and can distract engineers from understanding a problem or system. Geotechnical engineers should ensure that they do not underestimate uncertainty.

Accounting for uncertainty implies that good numerical modelling should consider more than one set of deterministic parameters and assumptions, which produce one set of results. Engineers must run their models many times to establish a range of possible outcomes.

The Illusion of Complexity being Better than Simplicity

In the era of relatively cheap, fast computers and numerical modelling software, it is now possible for firms and their engineers, including the young and the inexperienced, to build models of such complexity that no one knows what the models actually represent. There is a tendency to make models more and more complicated just because they can be quickly

built. In doing so, these engineers include everything they can think of, run the model once on a powerful computer with lots of memory, and then interpret the results without critical questioning.

Sometimes engineers and management deceive themselves that because models are complicated, they must be meaningful. Such presumption can lead to severe and dreadful errors. Good engineers always compare their model results to order-of-magnitude estimates and observed behaviour before accepting the outcomes. Even simple models (such as elastic models) lead to a deep appreciation of problems in the hands of these skilled engineers. After all, in the 1960s, engineers safely landed humans on the moon using the simple slide rule. (We must note, though, that bad engineering can also be done with simple models.)

The Illusion of Models being Right Just because They are Built

Due to the ubiquity of software, many models are built today based on user manuals. These manuals explain how to set up and run models rather than provide knowledge on underlying physical principles or behaviour. If the primary purpose of modelling is to clarify, not to confuse, to elucidate rather than obfuscate, this situation requires urgent addressing.

As alluded to above, the illusion of models being right just because they are built often arises when numerical modelling software tools are used by engineers not familiar with the software. It also appears when inexperienced engineers disappear into the world of computer simulations to escape interactions with other engineers and explain their reasoning.

In our opinion, to produce meaningful numerical modelling results, users must understand the mathematical and engineering principles underlying the software. Users must also have practical experience, including sound engineering judgment and how design works in the field. Without such knowledge, it is difficult for users to

- Decide which features must be modelled, ignored, or simplified
- Determine which assumptions are appropriate for a given problem or circumstance
- Understand the picture results are painting, and
- Accurately convey results and limitations to the design team, senior engineers, and management.

We cannot overemphasize this fact – designs or analyses with models we do not understand are DANGEROUS!

Who then Should Model – the Generalist Engineer or the Dedicated Modelling Specialist?

We want to address another dimension of modelling – the role of specialist modellers. Who should perform numerical modelling? Should it be done by the designers of any geotechnical engineering excavation or structure? Or should it be done by specialists focused on modelling?

In our opinion, for general problems, it is best to have design engineers who are familiar with the software (who properly appreciate the mechanics and limitations of the software) to conduct their own modelling. However, for more complicated analyses, such as nonlinear three-dimensional ground-structure interactions, it may be better to use specialized modelling experts. These specialists must tightly collaborate with the designers.

Lessons from Ancient Greece

We will conclude our conversation by examining an expression used when engineers blindly approach numerical modelling and accept its results. People describe such engineers as using models as oracles. However, a thoughtful look at how Ancient Greeks viewed oracles tells a different story that can actually help us in our modelling.

There are several accounts of ways in which Ancient Greeks dealt with uncertainty, particularly regarding the future. One way was to visit an oracle – a temple or holy place where someone with supernatural ability could provide insights into affairs. To ensure that they got the most useful oracle responses, Greeks had to phrase their questions carefully before visiting the oracle. They had to think wisely about the various ways in which their futures could unfold as part of this exercise.

Scholars tell us that the oracles often responded with riddles, which had to be solved. A response could be full of vivid imagery and could be puzzling. The one who consulted an oracle had to figure out what the answer meant and try to fit it into a likely future outcome. Based on this, the "client" would then decide what to do.

I cannot think of a better way to prepare to use models and better use modelling results than how the Ancient Greeks consulted oracles and used their responses. We must carefully prepare our questions and needs before we start modelling. It is only after such careful exercise should we begin to build our models.

Next, numerical modelling answers can present puzzling (and sometimes contradictory) outcomes amidst all the beautiful pictures. We must think carefully about these results and appropriately interpret them before converting them into practice.

https://www.rocscience.com/about/news-events/practical-numerical-modelling-lessons-from-ancient-greece

Preventing tunnel vision in underground projects: geological and construction risks

Evangelos Georgopoulos*

Going underground has reduced travel time, minimised obstacles and protected water reservoirs for thousands of years, with the oldest construction dating back to the 22nd Century BC at Babylonia. By their very nature, tunnels are dependent on geotechnical and hydrogeological conditions. Being constructed in soil-like material or hard rock, under the sea or inside aquifers in mountains, they are susceptible to geotechnical and construction risks which, if ignored, can result in fatalities, damages and lengthy litigation proceedings.

What are the most common tunnelling techniques?

Tunnels, irrespective of their purpose or final use, are constructed mainly with conventional (NATM, SEM, SCL, ADECO-RS and Drill & Blast) or mechanised techniques (TBM). The conventional techniques, excluding Drill & Blast, refer to similar methods. NATM (New Austrian Tunnelling Method), SEM (Sequential Excavation Method) and SCL (Sprayed Concrete Lining Method) are the exact same technique, whilst ADECO-RS (Analysis of Controlled Deformation in Rocks and Soils) utilises the core of ground ahead of the face. Typically, conventional tunnelling is linked with long tunnels in rural environments or short tunnels in urban environments, whereas the cost of a TBM (Tunnel Boring Machine) is high, both in money and time, and is based on the convergence-confinement method.

The mechanised technique with TBM can be further split into different machine types related to the ground and hydrological conditions, i.e. EPB (Earth Pressure Balance), slurry, rock and so on. The mechanised techniques are based on full-face support (in soil like materials, soft rocks and in the underground water table) and have the advantage of limiting disturbance to the surrounding ground and produce a smooth tunnel wall. Tunnels constructed with TBM reduce the cost of the tunnel lining, making them suitable for urban areas.

What are the geological risks in tunnelling?

Whilst tunnels make life easier, during construction, various geological risks lurk, linked mainly with the uncertainty of the geological and hydrogeological conditions. These risks have a higher likelihood of occurrence in rural environments where geotechnical investigation is limited due to access limitations or budget restrictions compared to urban environments.

Such uncertainty in conditions may result in the wrong estimation of the tunnel's geotechnical profile and the pre-determined excavation, impacting the support methods and systems that are implemented. The lack of predicting and understanding of the geotechnical profile, and potentially challenging conditions such as faults, thrusts and shear zones; pockets of soft material; saturated sand deposits; highly fractured, poor quality rock; karstified limestone; and high groundwater pressures, present significant geotechnical risks for tunnel construction.

The geotechnical risks are associated with safety issues, undesirable construction impacts (such as procurement of materials with a long lead time that were not in the original programme) and project delivery on time and within budget. If the risks are not properly mitigated, the consequences can be costly, including reduced tunnel advance rates, programme delays, personnel and public safety issues, and environmental or third-party impacts, such as damages on existing buildings or utilities.

What are the construction risks in tunnelling?

Constructing a tunnel or an underground excavation in an unknown or poorly described geotechnical environment can cause a series of failures at the tunnel's structure. Depending on the geotechnical material where the tunnel will be excavated, the groundwater regime, the overburden and the potential of induced stresses due to the proximity of active faults, thrusts and folds can result in different types of failures. These can include:

- the tunnel's crown collapse;
- the squeezing of the section and failure of the support's structural capacity;
- settlements propagated at the surface in shallow tunnels;
- flooding of the tunnel; or
- structurally controlled instabilities (wedge failure).

This is not an exhaustive list of the potential risks in tunnels but are some of the most common. Based on recent studies[1] a total of 378 incidents have been recorded during tunnelling since the beginning of the database from 1980 to 2019.

The main reasons for the construction risks associated with the geological uncertainty (geotechnical risks) are design errors, the lack of personnel awareness, deviation from agreed procedures or even acceleration of works to meet the construction programme or to achieve contract bonuses. The underestimation of the construction risks may result in fatalities, loss of equipment, programme delays or even problems with the budget and funding. All the above issues may result in arbitration or litigation to be properly solved.

How are tunnelling techniques related to risks?

The major difference between conventional and mechanised techniques, especially in soft rock and soil-like materials, is that the first is based on the relaxation of the surrounding rock mass to undertake the primary support for a portion of the developed stresses, whilst the latter is based on the full support of the excavation face to equilibrate the horizontal stresses (and water pressure if the excavation is under the aquifer) by applying a face pressure. Nevertheless, from the different methods of excavation, it has been evident that 48% of the incidents recorded were in NATM tunnels and 34% in TBM tunnels, whilst the remaining failures (18%) were either in Drill & Blast or open cut excavation tunnels (Cut & Cover).

Conventional vs mechanised techniques: which is riskier?

Conventional techniques are more vulnerable to geotechnical risks and are liable for more construction risks than mechanised techniques. Conventional techniques require the surrounding mass to relax prior to the installation of the primary support for the support system to undertake less loading than

the in-situ stresses, therefore, part of the surrounding mass to enter the plastification zone and start converging.

The cost of inaction: what are the consequences and how can risks be mitigated?

A failure to identify geotechnical risks can lead to fatalities and damages to equipment, which impacts the construction programme and budget.

Recent research[2] highlighted that fatalities in the tunnel construction industry between 1972 and 2012 were approximately 2.5 to 3 times higher than fatalities in all other construction industries, highlighting the importance of robust risk management.

Whatever the consequences, the impact on the programme can be critical; not only for the construction phase but also for the viability of the project itself and the funding.

For the tunnel project to be viable, certain mitigation measures must be identified and implemented for the risks to be reduced. These include:

- **Avoiding or reducing the risk** by increasing the geotechnical investigation budget, trusting an experienced designer and properly educating the construction personnel.
- **Applying risk mitigation measures** to decrease the severity or consequences of a risk by properly designing the excavation method and support system, as well as improving the stability conditions of potentially unstable ground or wedge.
- **Improving communication** with independent technical advisors that can opine on the potential risks.

Being proactive about the identification of geotechnical and construction risks by engaging experienced and skilled individuals can help to avoid 'tunnel vision' in challenging underground projects. Although susceptible to risks, tunnels will always be required for many different purposes, but detailed risk identification can result in a more efficient method of construction and avoid the potential of arbitration or litigation.

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[1] Konstantis, S. & Spyridis, P. Tunnel failure trends and risk management, Tunelling Journal, October/November 2020.

[2] Kikkawa N, Itoh K, Hori T, Toyosawa Y, Orense RP. Analysis of labour accidents in tunnel construction and introduction of prevention measures. Ind Health. 2015;53(6):517-21. doi: 10.2486/indhealth.2014-0226. Epub 2015 May 29. PMID: 26027707; PMCID: PMC4667042.

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Giant karst cave encounter in China

Qing Weichen, Senior Engineer, China Railway Eryuan Engineering Group

Passage through the Yujingshan Mountain in the middle of the Chengdu-Guiyang high-speed railway in Weixin County in Yunnan Province, required a 6.3km tunnel heading into one of the most intensive karst development regions in China. The region is also the home of the Miao and Yi ethnic minorities and is a sensitive ecological environment in which heavy construction work is difficult.

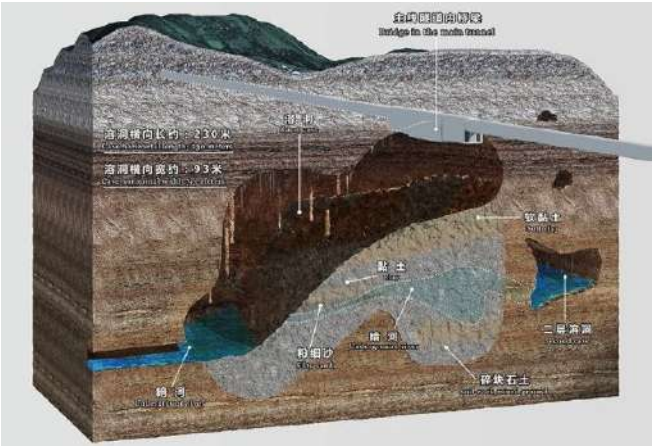


Fig 1. Giant karst cave and underground river system

With a design speed of 250km/hr, the railway will connect the city of Chengdu, the capital of Sichuan Province, and Guiyang, the capital of Guizhou Province and cut current rail travel time from 14 to three hours.

In July 2016, at about 2km from the portal and 60m below ground, a giant karst cave of 95m long x 230m wide x 50m-120m high was discovered (Fig 1). The deposits at the bottom of the cave are 30m-90m thick, with a scree slope of 30-40 degrees. At the lower side of the slope emerges a large underground river of 5m-15m wide that runs for 18km and has a flow of 70m3/sec in the rainy season.

The solution to continue though the route through such a giant and complicated karst cave was to suspend a structure near the roof of the cave, with a distance of 40m from the cave bottom and running 110m perpendicular to the water surface of the underground river. The conditions presented four major and difficult construction challenges.

Scale of the giant karst cave

The first was for construction safety. Tensile joints and fissures in the rock mass provided for poor stability around the tunnel, with frequent rock falls from the cave roof, some with a maximum diameter of 15m. These directly threatened the safety of the construction workers and equipment. How to ensure construction safety of the structure across the giant cave was challenge one.

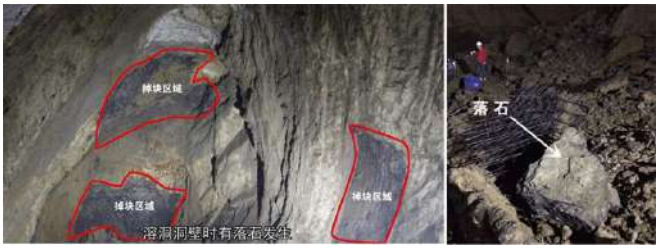
The second challenge was for structure and rail operation safety. The tunnel is 40m above the bottom of the karst cave and the overhanging length is 90m. What kind of reliable structure should be selected to meet the strict track settlement control requirements of a high-speed railway was challenge two.

Thirdly, for such a giant karst cave and no matter the adopted solution, the engineering is extremely difficult and would take time. With just three years remaining before the programmed opening of the railway, how to work out a solution as soon as possible and execute it efficiently to ensure the timely opening of the line was challenge three.

Underground river at the bottom of the karst cave

Environment protection was the fourth challenge. Water resources in the project location are scarce. The underground river in the cave is the main water source for downstream villages and the only water source for a downstream hydropower station (Fig 2). How to keep the river flowing, maintain the balance of the existing groundwater network, and protect the original ecosystem was challenge four.

To address the challenges, all the stakeholders formed a team to overcome difficulties, and solved the construction problems through scientific and technological research and repeated many studies and comparisons of different solutions.



Rock falls from the cave roof

With a clear height of the cave of 120m, and the unstable deposits at the bottom of the cave, adopting a traditional solution of a scaffolding platform to protect the cave roof, and to build the railway structure inside, would be difficult, the duration would be long, and the number of construction workers needed high, with their safety not guaranteed. For this reason, the solution was to completely backfill the cave with spoil. The solution adapted to local conditions and recycled the drill+blast excavation spoil. The construction is the

simplest, the number of construction workers is fewest, and there would be no casualties or damage to equipment during the construction.

In response to challenge two, the solution to the structural problem of creating a high-speed railway crossing in a giant karst cave was to construct a tunnel through the backfill body and then erect a large-span bridge inside the tunnel (Fig 3). High-pressure grouting was used to stabilize the backfill and surrounding rock and support excavation of the 432m^2 super-large tunnel section in five top-down benches. To compensate for the potential of uneven settlement and deformation in the foundation, the design imitated the spine of an animal, dividing the tunnel structure into 5m long segments set wide with deformation joints between adjacent segments.

The large-span bridge inside the tunnel was built in a 38m+108m+38m three-span continuous beam as the bearing structure to meet the limits of high-speed rail track deformation of not greater than 15mm.

Fig 2. Villages and a power station downstream depend of the underground river

An automatic monitoring system was installed and a compensation grouting system was established to control any differential settlement of the foundation.

In response to challenge 3, a series of fast construction measures were developed.

First, five adits were excavated on the vertical and at 20m between them, to complete the huge 1.08 million m^3 backfill quantity of the 120m high void (Fig 4). The backfill was divided into five layers and completed layer by layer from the bottom-up, taking eight months to complete the operation.

To speed up the progress, a special side-wall formwork was created to cast side wall concrete, and a Bailey beam truss trolley was developed to cast the arch lining and bridge structure in the tunnel. This parallel construction of the tunnel lining and the cast-in-place bridge saved three months on the construction period.

To protect the environment and address the issues of challenge 4, a three-dimensional groundwater drainage system was built to maintain the original groundwater system. Before backfilling, a 450m length of the underground river was redirected to the outside edges of the cave. A layer of large rocks was placed in a 3m area around the outer walls of the cave at 20m above the original underground river level to create a three-dimensional seepage layer to channel fissure water around and back into the underground river system.

Through the above measures, the construction and structural safety issues of an overhanging tunnel in a huge unstable cave were successfully solved and this guaranteed the smooth opening and operation safety of the Chengdu-Guiyang high-speed railway. This solved the technical challenges of creating an overhang karst tunnel, formed the construction technology of crossing a giant karst cave, and improved the ability of selecting a high-speed railway route in karst areas.

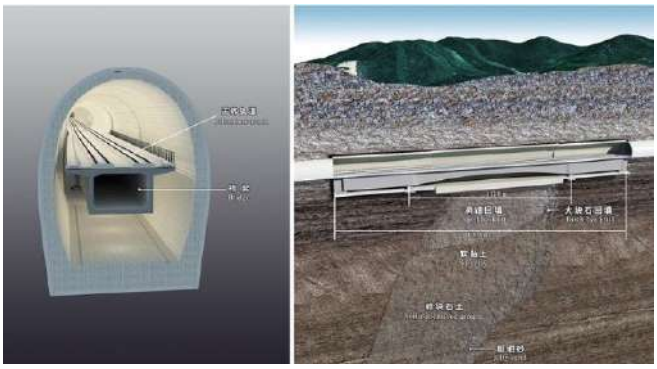


Fig 3. A bridge structure within a tunnel in complete backfill of the giant void carries the railway across the karst cave

The spoil of the earlier heading excavation was recycled into the cave, thus saving arable land, and the three-dimensional groundwater drainage system, to maintain the original groundwater system and protect the ecological environment of the Miao and Yi communities, realized a harmony between infrastructure engineering and nature. The new line will greatly facilitate travel for local people and will promote sustainable economic development along the line.

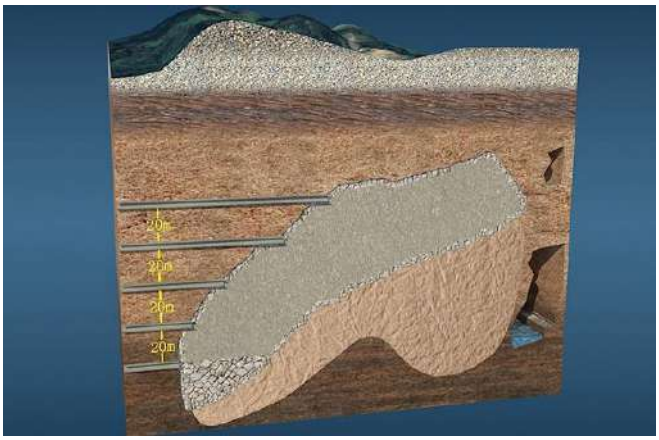


Fig 4. Five adits were created to complete the bottom-up backfilling of the cave

Since the opening of the new line in late 2019 and the start of high-speed train operations, the structure across the giant karst care has performed successfully. The measured maximum settlement of the bridging tunnel at its invert is 7mm, which meets the high-speed rail structural safety requirements, and the water volume of the downstream underground river is stable, meeting the production and domestic water demands of the local villages and the hydropower plant.

In the 2020 series of the international ITA Tunnelling and Underground Space Awards, the Yujingshan Mountain crossing of the giant karst cave and the management treatment of the underground river as designed by the China Railway Eryuan Engineering Group and built by the No 5 Engineering Group Co of the China State Railway Group, was the winner of the *Overcoming the Challenge* category.

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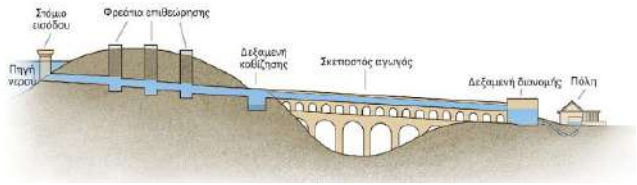
Το ρωμαϊκό έργο υδροδότησης του Γυθείου

Το Γύθειο, την περίοδο της ακμής του, απετέλεσε κέντρο του Κοινού των Ελευθερολακώνων, εξελίχθηκε σε κύριο λιμάνι της Λακωνίας ενώ ο πληθυσμός του ανερχόταν σε πάνω από 20.000 κατοίκους. Η ύδρευση του Γυθείου γινόταν από τον ποταμό Σμήνο με ένα σημαντικό τεχνικό έργο που περιλάμβανε τόσο υδραγωγείο όσο και δίκτυο ύδρευσης με κανάλια, ένα έργο ζωτικής σημασίας για την τότε σχετικά πυκνοκατοικημένη πόλη.

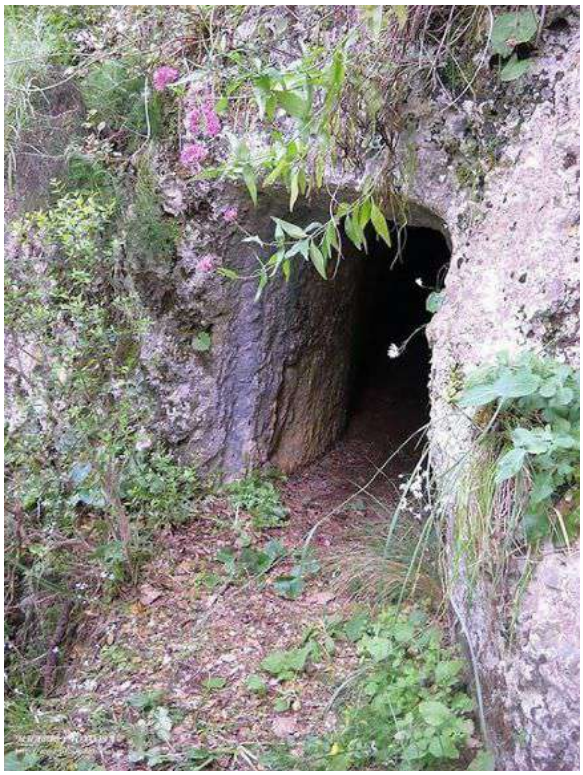


Εικ. Σχέδιο με δυνητικά έργα σε ένα έργο υδροδότησης πόλης

Τα νερά του φημισμένου για την «γλυκύτητα» των νερών του Σμήνου (Παυσανίας, ΙΙΙ, 24, 9), έδωσαν τη λύση στο ζήτημα υδροδότησης της τότε πρωτεύουσας των Ελευθερολακώνων του Γυθείου.

Σήμερα διασώζονται ελάχιστα τμήματα του υδραγωγείου μέσα στην πόλη και στην Περιφέρεια Προσηλίου (τ. Στροτζά, Μπαρδουνοχώρια) κοντά στο φαράγγι του Σμήνου ποταμού, όπου υπάρχουν ακόμη υπολείμματα των τεχνικών έργων για την μεταφορά του νερού. Το Προσήλιο διοικητικά ανήκει σήμερα στον Δήμο ανατολικής Μάνης (πρώην Καποδιστριακός Δήμος Σμύνους), και περιλαμβάνεται σε μία ομάδα χωριών της βόρειας Μάνης, γνωστών ως Μπαρδουνοχώρια.

Ίχνη του αρχαίου δικτύου ύδρευσης του Γυθείου, όπως για παράδειγμα κανάλια, πελεκημένα σε βράχους αυλάκια και γεφύρια για τη διέλευση του δικτύου ύδρευσης πάνω από τους χειμάρους της περιοχής, εντοπίζονται σε διάφορα σημεία κατά μήκος του ποταμού Σμήνου, και στην ευρύτερη περιοχή του ομώνυμου δήμου.



Εικ. Με κατάλληλη τεχνογνωσία, υπομονή και επιμονή, κατασκεύασαν σήραγγα με μήκος περίπου 30μ., ύψος από 1,2μ έως 1,4μ. και πλάτος 0,8μ.

Επίσης, στις δυτικές πλαγιές στο λόφο της Ακρόπολης Γυθείου, σώζονται τα ερείπια του Ρωμαϊκού υδραγωγείου (μια δεξαμενή όπου κατέληγε το μήκους 18 χλμ. υδραγωγείο) καθώς και ίχνη παλαιοχριστιανικής βασιλικής του 3ου-4ου αιώνα

Το έργο ξεκίνησε από τη **θέση Τζονάκες (Στροτζά).** Το νερό μεταφερόταν μέσα από ένα κλειστό πήλινο αυλάκι. Το αυλάκι αυτό ακολουθούσε τη δεξιά όχθη του ποταμού, μέχρι που το πέρασμα έγινε αδιάβατο, οπότε οι κατασκευαστές έχτισαν γεφύρι και συνέχισαν από την αριστερή πλέον όχθη του ποταμού, αλλά και από εκεί συνάντησαν νέο εμπόδιο, **στη θέση Γαλαράκι.**

Με κατάλληλη τεχνογνωσία αλλά και με μεγάλη υπομονή και επιμονή κατασκεύασαν σήραγγα με μήκος περίπου 30μ., ύψος από 1,2μ. έως 1,4μ. και πλάτος 0,8μ. για να περάσει.

Ακόμα και σήμερα, στην είσοδο και την έξοδο της σήραγγας, μπορείς να διακρίνεις τις ολόγλυφες μορφές του Ηρακλή.

Η απεικόνιση αυτή είναι υπόμνηση ότι το έργο απαίτησε ηράκλεια δύναμη για την ολοκλήρωσή του.

Το υδρευτικό κανάλι, άλλοτε υπόγεια, άλλοτε υπέργεια συνέχισε την πορεία του μέχρι το Γύθειο στο λόφο πάνω από την Ακρόπολη (Άγιος Τρύφωνας).

Εκεί κατασκευάστηκε νέα γέφυρα και μια μεγάλη κλειστή θολωτή δεξαμενή μήκους 17μ. και πλάτους 4μ. χωρισμένη σε δυο διαμερίσματα.

Από το δάπεδο της δεξαμενής ξεκινούσε ένα δίκτυο πήλινων σωλήνων για την υδροδότηση των περισσότερων σπιτιών της πόλης και των δημοσίων κτηρίων.

Παράλληλα υπήρχαν σωλήνες που κατέληγαν σε πολλές δημόσιες κρήνες (βρύσες).

Εικ. Ακόμα και σήμερα, στην είσοδο και την έξοδο της σήραγγας (με μήκος περίπου 30μ., ύψος 1,3 μ. και πλάτος 0,8μ.) στη θέση Γαλαράκι στην περιοχή Προσηλίου (Μπαρδουνοχώρια), διακρίνονται οι σχεδόν ολόγλυφες μορφές του Ηρακλή που υποδηλώνουν το τιτάνιο έργο που απαιτήθηκε για την διάνοιξη. Φωτ. www.prosiliolakonias.gr

Ένας μύθος του αρχαίου Γυθείου μας περιγράφει την κατασκευή αυτού του τεράστιου έργου:

"...Στο Γύθειο...υπήρχε ένας βασιλιάς που είχε μια πεντάμορφη κόρη. Για την αγάπη της φιλονίκησαν ο Ηρακλής κι άλλο ένα αρχοντόπουλο. Η βασιλοπούλα τότε προκειμένου να διαλέξει τον καλύτερο τους ανέθεσε να κάνουν ένα μεγάλο έργο. Οι μνηστήρες πράγματι κατάφεραν μετά από πολύ κόπο να κατασκευάσουν το έργο υδροδότησης του Γυθείου. Η βασιλοπούλα τότε βρέθηκε σε δυσκολότερη θέση και επειδή δεν ήθελε μονομαχία θανάτου μεταξύ τους, πήγε στο μέρος που άρχισε το έργο και αυτοκτόνησε δίπλα σε μια ροδοδάφνη που από τότε ονομάζεται πικροδάφνη."

(Το άρθρο αλίευσε ο Δρ. Ιωάννης Στεφανάκος στο https://elladitsamas.blogspot.com/2021/02/blog-post_24.html?fbclid=IwAR2GCB05R21uwt0NwR4L4cdGGmOPjrIU9MfO4iDqq6wuO3R97NkbwBQtZpE&m=1)

HS2 prepares to excavate 21km route under London 11 Feb 2021

Jonathan Rowland, *TunnelTalk*

Of the 45km of twin tube bored tunnels to be constructed as part of the 225km High Speed 2 (HS2) rail project in the UK to link Birmingham and London, just under half is located under west London, between the HS2 southern terminus at Euston Station and a portal at West Ruislip, just inside the orbital M25 highway. The 21km route presents a complex engineering and logistical challenge for main contractor Skanska-Costain-Strabag JV (SCS). Jonathan Rowland spoke with **Dave Terry**, Tunnel Engineering Lead for SCS, **Michael Greiner**, Tunnel Manager for SCS, and **Eddie Woods**, Head of Tunnelling and Underground Structures for project delivery partner HS2 Ltd, to report the details of the TBM drives and the station cavern excavations that form the major part of the £3.3 billion design-build contract awarded to SCS in 2017.

Six TBMs of different diameters and through varying geological conditions in three sections will be used to excavate the 21km route of the London running tunnels of the HS2 rail project in the UK (Fig 1).

- 8km x 8.8m i.d. Northolt West tunnel between West Ruislip portal and Greenpark Way ventilation shaft.
- 5.5km x 8.1m i.d. Northolt East tunnel between Greenpark Way and Old Oak Common Station.
- 7.2km x 7.5 m i.d. Euston tunnel between Old Oak Common Station and Euston Station.

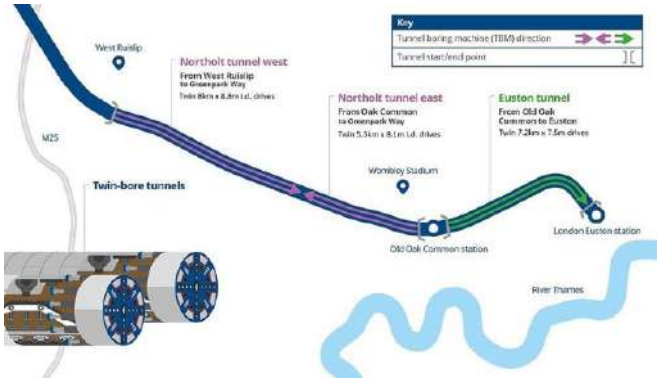


Fig 1. HS2 London tunnels from Euston to West Ruislip

A seventh TBM will excavate a 1km x 6.1m i.d. logistics tunnel that will provide access from the main Atlas Road construction compound to Old Oak Common Station, the launch site for the Northolt East and Euston TBMs. It will be used to bring construction materials into the tunnels, including the precast concrete lining segments, and to remove muck.

The first TBMs procured and to be launched are two Herrenknecht EBPMs to excavate the Northolt West drives, the longest of the three alignments. These will be followed by procurement of the Northolt East TBMs in early 2021 and finally of the two machines for the Euston drives in late 2021. The main TBMs will be procured new and designed specifically for the project; a refurbished TBM is likely to be used to bore the logistics tunnel with procurement underway.

Changing and challenging geological conditions

Advancing from the West Ruislip portal, the Northolt West drives are expected to face challenging mixed-face geological conditions, according to Terry. "The location of the portal means that the TBMs soon encounter Seaford Chalk, with water pressures up to 3 Bar. For the first 3km of the drive, the TBM will negotiate a mixed face of chalk and the variable sequences of the Lambeth Group, with some significant sand channels. As the drive proceeds, the chalk drops away from the alignment and the TBM continues through the Lambeth Group with the sand channels present up to the shaft."

To assist excavation through the challenging ground conditions, EPBMs will be used with a spherical bearing to allow for translation or tilting of the cutterhead, providing a greater degree of accuracy in terms of steering the machine, as well as controlling face pressure, cutter load, and settlement, "all of which are an advantage when you have mixed ground conditions," said Greiner.

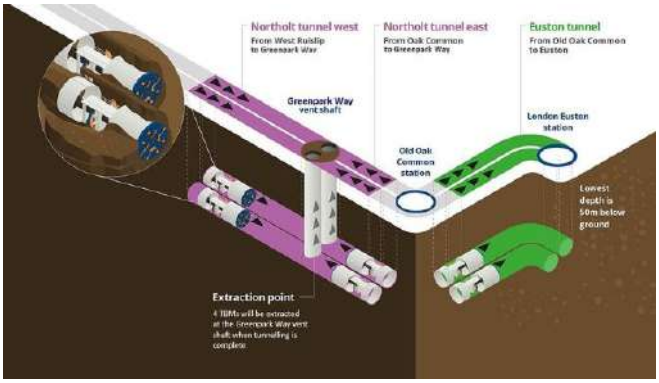


Fig 2. Launch location and advance direction of the six main TBM London drives

The Northolt West TBMs will also feature advanced automation technologies. Instead of traditional manual transfer of the segments from the quick unloader to the segment feeder at the back end of the TBM, the transfer will be operated automatically, as will the removal of the wooden spacers that are placed between the segments when stored and transported. At the front end, sensors and cameras will assist one operator to build the rings. Steering of the gantries will also be automatic.

Automation will continue to be pushed through the project to "further innovate, learning the lessons of the earlier drives and applying them to later TBMs," said Greiner.

"One of the priorities is to take people out of the underground excavation environment," said Woods. With a 40-year career in the industry, his previous projects include the twin tube TBM drives on the Channel Tunnel rail link, part of the HS1 project, under the suburbs of north London. "When we were constructing the HS1 TBM drives, we looked at every activity that took place underground and mechanised whatever we could. As a result, we achieved a much lower accident rate than other major tunnelling projects at the time. Now on HS2, advanced automation is allowing us to reduce the number of people working underground even further."

Reducing the number of workers also helps when undertaking projects in areas where operatives are either in short supply or in demand. "It will get quite busy underground in London over the next few years and so competent professionals may become more difficult to find," said Greiner. "Automation helps to de-risk this element of the project."

Delivery of the Northolt West Herrenknecht EPBMs is expected by the end of 2021 for start of excavation by mid-2022.

Northolt East and Euston alignments

In addition to the Northolt West machines, the Greenpark Way working site will also receive those excavating the

Northolt East TBMs at the end of their twin 5.5km x 8.1m i.d. drives from Old Oak Common (Fig 2).

The geology along the Northolt East alignment is again mixed but more benign than the Northolt West drives, without the hydrogeological challenges posed by the chalk. "From London Clay around Old Oak Common, the TBMs will encounter, the Harwich Formation and into the variable deposits of the Lambeth Formation as the reception shaft at Greenpark Way is approached," said Terry.

The London terminus of HS2 at Euston Station

The 7.2km x 7.5 m i.d. Euston drives between Old Oak Common Station and Euston Station present the most consistent geological profile with the entire route lying within London Clay.

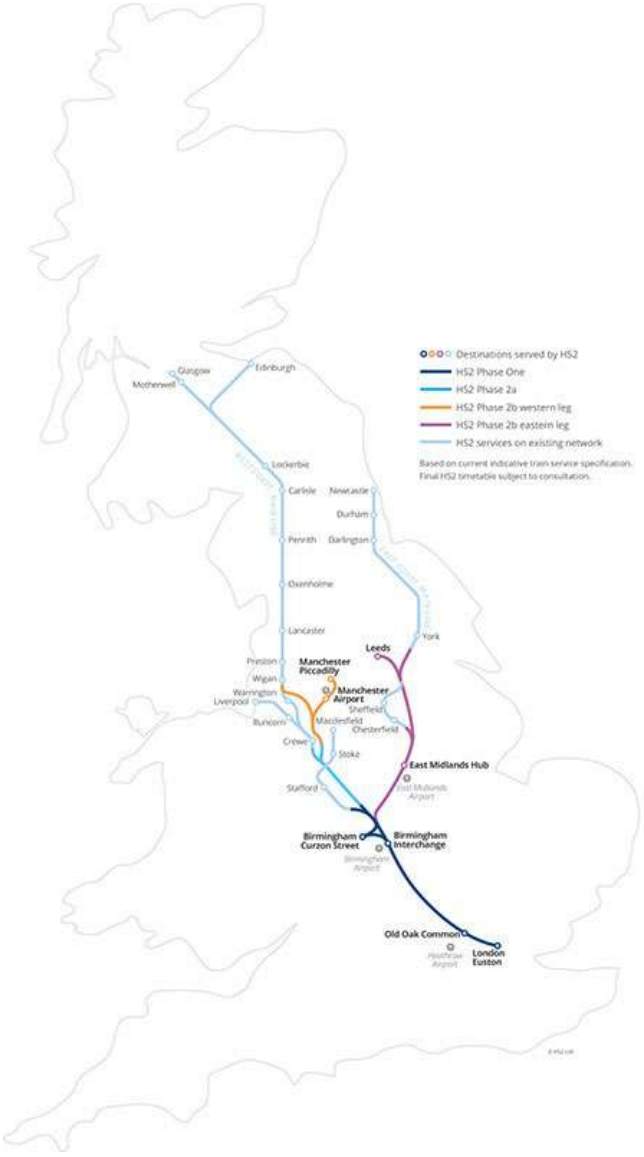
As the geology of the route changes, so the specifications for the TBMs will change and not all may require the spherical bearing of the first two machines. "We will have to look in detail at this, when we come to it," said Greiner. "Because of the ground conditions, a spherical bearing lends itself best to the Northolt West drives through the chalk but it might also be an option for Northolt East."

Although the geology is mixed along the route, it is "nothing that has not been experienced before," said Terry and is similar to the geology of some elements of other projects in London. Some sections of the Tideway CSO drives under the Thames in London, for example, have faced similar conditions, as did the TBM and SCL excavations for the Crossrail project. "The TBMs will be designed to manage the mixed face and hydrogeological challenges, but it does pose much more of a challenge for the cross passages."

There are 52 cross passages to be constructed along both Northolt and the Euston alignments. These are planned to be SCL construction, with a waterproofing sheet membrane and a secondary cast-in-place concrete lining. "These excavations present one of the greatest challenges in the London HS2 works", said Terry.

The cross passages will be constructed as the main tunnel proceeds, "which raises the first of the challenges, as we effectively have to maintain a tunnelling site within a tunnelling site," he continued. To facilitate construction, innovative openings in the segmental lining design will be used. These mean that "we do not have to separately prop up the running tunnel. We just take out the opening and work through that to construct the cross passage," he said.

The hydrogeological conditions along the Northolt West section, "will require either dewatering, depressurisation or, in some cases, ground treatment, to construct the cross passages. With most of the route located under an operational railway, any ground treatment will need to be applied from inside the tunnel, posing an added challenge in terms of logistics," Terry continued.



Planned UK high-speed rail development

Segment rings and diameters

The running tunnels will be lined with a reinforced precast concrete segmental lining with seven main segments in each ring. In the Northolt West alignments, the segments will be 350mm thick x 1.9m wide and are rebar reinforced. Rebar is also currently specified for the Northolt East and Euston alignments, but there is "an ongoing value engineering exercise to explore if it may be possible to change to a steel fibre solution in part of those tunnels", said Greiner. The Northolt East segments will be 340mm thick x 1.9m wide, while those for the Euston drives are smaller again at 325mm thick x 1.8m wide.

The varying internal clearance of the segmental lining raises the question of why each of the three alignments has a different internal diameter and all are smaller than the 9.1m i.d. of the 16km Chiltern tunnel drives also on the HS2 route. "It is basically aerodynamics," explained Woods.

"The pressure generated when a train passes through a tunnel increases with its speed but can be mitigated by increasing the internal diameter of the tunnel," he explained. "With trains running through each of the HS2 London tunnels at different speeds, as they accelerate out of or decelerate into Euston Station, different internal diameters are specified."

The largest internal diameter is therefore needed for the Northolt West tunnels, where trains will be travelling fastest, reducing in diameter towards Euston. In the Chiltern tunnels, which are the longest on the route, trains will run at up to 320km/hr and the larger diameter of this route reflects the need to manage higher internal aerodynamic pressure.

Reducing the diameters also saves in excavation and material costs with the smallest diameter Euston drives costing less to drive and line per ring than the largest diameter Northolt West alignments.

Integrating with station construction

Although station construction is not within the SCS contract, there is significant interaction with the station works contractors Balfour Beatty Vinci Systra JV at Old Oak Common and Mace/Dragados at Euston.

From the Old Oak Common Station box, SCL stub tunnels will be constructed for the Euston drives to allow full assembly of the TBMs before launch and, at the other end of the box, the Northolt East TBMs will launch from an ancillary shaft connected to the station box by SCL headings. The Atlas Road logistics TBM tunnel will also break through into the Old Oak Common Station box.

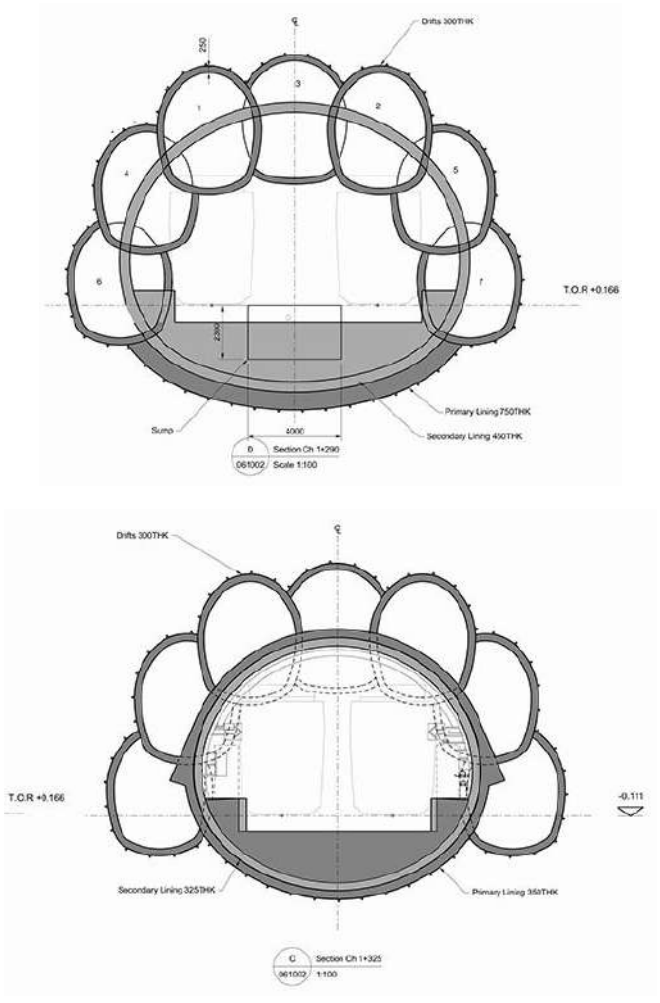


Fig 3. Stacked-drift construction of Euston Station cavern

At Euston, SCS is responsible for construction of the 16m wide x 12m high cavern to accommodate the turnout that will enable the HS2 service to run with the required frequency alongside what is already one of the busiest mainline stations in the UK.

"We are constructing the cavern using a stacked-drift method, whereby a series of smaller diameter SCL headings are excavated around the cavern crown profile to form an arch, under which the main cavern is then excavated to the required dimensions," explained Terry (Fig 3). "This provides much lower potential for ground movement, which is vital at Euston, as we are excavating either under or next to the approaches to the existing main station."

Constructing under intense public scrutiny

The ability of the project to control ground movement and construct the various underground elements safely came under scrutiny in 2020 during a court case brought by a local resident, who claimed that parts of the design were unsafe. HS2 ultimately won the case with the judge commending the highly skilled team assembled by HS2 Ltd.

"We are pleased that this matter has now concluded and we can move forward with the detailed design of the railway," HS2 Ltd said in a written statement. "SCS and HS2 Ltd have gathered a team of experienced professionals to both guide the design and to ensure constructability."

This collected expertise and experience will be a key factor in making sure HS2 is a success, not just in London but along the whole route. Monthly collaboration group meetings involve all of the HS2 main contractors, as well as external experts. "The group is probably the best meeting I go to," said Woods. "It is positive. It is about solving problems, which is what we do in tunnelling."

With construction of HS2 still controversial and numerous high-profile critics of the project, including some MPs, ready to highlight any perceived mistake, this level of skill and collaboration will be invaluable to the success of the project in meeting its target completion date of 2028-2031.

References

- HS2 prepares TBMs, shortlists systems and M&E bids – *TunnelTalk,* February 2021
- First two TBMs for London route ordered – *TunnelTalk,* October 2020
- HS2 station shortlist as work sites mobilise – *TunnelTalk,* June 2020
- Civil contract awards for UK HS2 Phase 1 – *TunnelTalk,* July 2017

(TunnelTalk, 11 February 2021, https://www.tunnel-talk.com/UK-12Feb2021-HS2-prepares-for-underground-link-with-London-terminus.php)

Important Civil Engineering Abbreviations

The common abbreviation used in civil engineering are as follows:

A.A.S.H.T.O – American Association of State Highway Transport Official

A.C.I – American Concrete Institute
A.R.E.A – American Railway Engineering Association
A.B – Anchor Bolt Or Asbestos Board
AC – Asphalt Concrete
A.S.C – Allowable Stress of concrete
A.S.T.M – American society for testing materials
AC – Asbestos cement
AE – Assistant Engineer
APM – Assistant Project Manager

B.M – Benchmark
B.M – Bending moment
BLK – Block Work
BOQ – Bill Of Quantities
BRW – Brick Retaining Wall
BWK – Brick Work
B.O.F – Bottom Of Foundation
BHK – Bedroom, Hall, Kitchen

C.I.Pipe – Cast iron pipe
C.I.Sheet – Corrugated Iron sheet
CL- Centre Line
CRW – Concrete Retaining Wall
CBW – Concrete Block Wall
CIP – Cast In Place
CMU – Concrete Masonry Unit
CJ – Construction Joint
CC – Centre To Centre
CC – Cement concrete
CE – Chief Engineer
CP – Cement plaster
CPM – Critical path method
CS – Comparative statement

D – Diameter
DL – Development Length
Dia – Diameter
DIM – Dimension
D.L – Dead load.
DPC – Damp proof course
DPR – Daily Progress Report
DRG – Drawings
DWLS – Dowels

EJ – Expansion Joint
E.L – Environmental load
EL – Existing Load
EGL – Existing ground level
ELCB – Earth Leak Circuit Breaker

F.M – Fineness Modulus
Ft – Foot Or Feet
FL – Floor Level
FGL – Formation ground level
FOC – Factor Of Safety

GL – Ground Level GL – Ground level
GP – Ground plane

HFL – Highest Flood Level
HAC – High Alumina Cement
HP – Horizontal plane

IOM – Inter-Office Memo
ISI – Indian standard institute
JE – Junior Engineer

JST – Joist

Kg – Kilogram

L.L – Live load
LW – Light Weight
LWC – Light Weight Concrete
LC – Lime concrete

M – Meter
MM – Millimeter
MB – Measurement book
MCB – Miniature Circuit Breaker
MEP – Mechanical Electrical Plumbing
MFL – Maximum Flood Level
MRC – Material Receipt Challan
MT – Metric Tonnes

N – Newton
NCF – Neat cement finishing

OPC – Ordinary Portland Cement
OGL – Original ground level
OSR – Open Space Reservation Area

PC – Pile Cap
PC – Precast Concrete
PCC – Plain Cement Concrete
PERT – Programme Evaluation and Review Technique
PL – Plinth level
PM – Project Manager
PO – Purchase Order
PPE – Personal Protective Equipment
PPR – Poly Propylene Random
PVC – Polyvinyl chloride
PVC – Polyvinyl Chloride
PSF – Pound Per Square Foot
PSI – Pound Per Square Inch
PWD – Permanent Works Engineer

QC – Quality control
QS – Quantity Surveyor

RC – Reinforced Concrete
R.B.W – Reinforced brickwork
RBC – Reinforced Brick concrete
RCC – Reinforced Cement Concrete
RMC – Ready Mixed Concrete concrete
RL – Reduced level

SCC – Self Compacting Concrete

STP – Sewage Treatment Plant
SRC – Sulphate Resisting Cement
SWG – Standard wire gauge

TB – Tie Beam
TBM – Tunnel Boring Machine
TDS – Total Dissolved Solids
TOB – Top Of Beam
TMT – Thermo Mechanical Treatment
TOC – Top Of Concrete
TOW – Top Of Wall

U.S.C – Ultimate stress of concrete
UPVC – Unplasticized Polyvinyl chloride
USD – Ultimate strength design

VP – Vertical plane

W.C – Water closet
WL – Working Level
W.S.D – Working stress Design
WO – Work Order

https://www.onlinecivilforum.com/site/abbreviations-used-in-civil-engineering/

Και άλλα αρκτικόλεξα από την δική μας εμπειρία:

AGI – Additional Ground Investigation

BGL – Below Ground Level
BH – Borehole

CAI – Cerchar Abrasivity Index
CD – Conceptual Design
CPO – Central Planning Office DBR Design Basis Report

DD – Detailed Design
DfS – Departure from Standard
DGWL – Design Ground Water Level
DGS – Design Geotechnical Sections
DOPU – Drop Off/Pick Up

EC7 – Eurocode 7
EC8 – Eurocode 8
EV – Emergency Vehicles
EXW – Expressway

FoS – Factor of Safety

GAR – Geotechnical Appraisal Report
GDR – Geotechnical Design Report
GFR – Geotechnical Factual Report
GIR – Geotechnical Interpretive Report
GSAS – Global Sustainability Assessment System
GWL – Groundwater Level

LL – Liquid Limit

MG – Made Ground
MS – Milestone

N.A.T.M. – New Austrian Tunnelling Method
NOC – Non-Objection Certificate

PD – Preliminary Design
PL – Plastic Limit
PLI – Point Load Index
PM – Project Manager
PSD – Particle Size Distribution

QD – Quaternary Deposits

SDI – Slake Durability Index

TP – Trial Pit

UCS – Unconfined Compressive Strength

WC – Water Content

Features from the Field: Shear Zones and Mylonites

Samuele Papeschi, Sandra McLaren and Hannah Davies

Dextral, ductile shear zones crosscut foliated schist at Cap de Creus (Catalona, Spain)

The San Andreas Fault in California, the Alpine Fault in New Zealand, or the Main Frontal Thrust in the Himalayas are some of the most famous and largest fault zones that accommodate the relative displacement between two adjacent crustal blocks.

Surface rupture along the Mt. Vettore fault ("Scoglio dell'Aquila" zone) with local throw exceeding 2 meters, mainly generated after 30 October 2016 earthquake (Norcia -Italy). Faults like this one are common structures in the upper crust, where they localize seismogenic deformation.

Such faults, however, represent only the shallower expression of something much bigger: a crustal **shear zone**. In the first 10 kilometers or so of the crust, rocks are cold (usually below 300 °C) and tend to fracture when subject to deformation, producing cracks and fractures that may join together to form a **fault zone**. Within a fault zone, deformation, which in general is accompanied by earthquakes, further fracture, crush, and pulverizes geologic materials, producing a variety of rocks such as **cataclasite**, **gouge**, and **pseudotachylite** (more about them in the next posts of the series). Material scientists and geologist call this behavior **brittle regime,** which occurs when deformation occurs by loss of cohesion of materials and strain localizes on discrete planes and structures.

But, what happens at depth? It is much hotter in the Earth's middle and lower crust (300 – 800 °C) and there rocks behave very differently than those in the shallow crust. Hotter, deeper rocks are more similar to plastic and, at geologic timescales, they flow rather than fracture.

Sheared metagranodiorite from the Uchee Belt, Atlanta, Georgia (USA)

Wait! Rocks…flow? Yes, like most materials, higher temperature facilitates plastic deformation. Think of chocolate, for instance: it is easy to snap a chocolate square from a chocolate bar when it is cold. However, when it is hot in the summer, chocolate bends and flows, making your chocolate eating experience quite disappointing. Another example is represented by how blacksmiths shape metal: they need to heat metal up in a furnace in order to forge it. Otherwise, at low temperature, metal is quite resistant and may break during deformation.

Rocks are no different. At depth, with high temperature, they flow, shear, squeeze, and deform by crystal-plastic mechanisms, without breaking. Rocks are deformed, sheared, squeezed, and folded without fracturing and producing earthquakes. We have shown examples of this behavior – which geologists call **ductile regime** – in previous posts of the Features from the Field series: e.g. boudinage, foliation, and folding.

Mylonitic metagranite from the Sierra Nevada, Spain. The original minerals constituting the metagranite (grey = quartz; white: feldspar; black: tourmaline) were deformed and stretched. Tourmaline is stronger than quartz and feldspar and shows brittle behavior even in this mylonitic sample.

A **shear zone** is the ductile, deep equivalent of a fault zone. Shear zones are generally wider than faults and may accommodate displacements over a range of scales from some centimeters to tens of kilometers. Strain is considerably higher in shear zones with respect to the surrounding rocks, which may appear weakly deformed or non-deformed at all. Inside a shear zone, deformation forms spectacular well foliated,

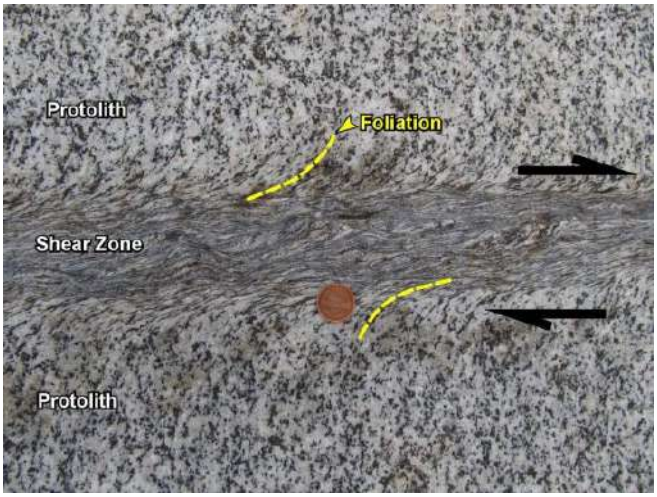
deformed and commonly lineated rocks called **mylonite**. The term mylonite comes from the Greek μύλος *mylos*, meaning 'mill', as early authors thought these rocks derived from crushing of the surrounding rocks. Today we know –also thanks to lab experiments– that dynamic recrystallization and metamorphic reactions instead produces the strongly deformed and fine-grained structure of mylonites.

Mylonites contain a series of structures that indicate ductile grain-size reduction of pre-existing rocks and may be useful to tell the direction of flow during shearing. Metagranites (i.e. deformed igneous rocks) show some of the most classical example of the development of shear zones and mylonitic structures starting from relatively intact rocks.

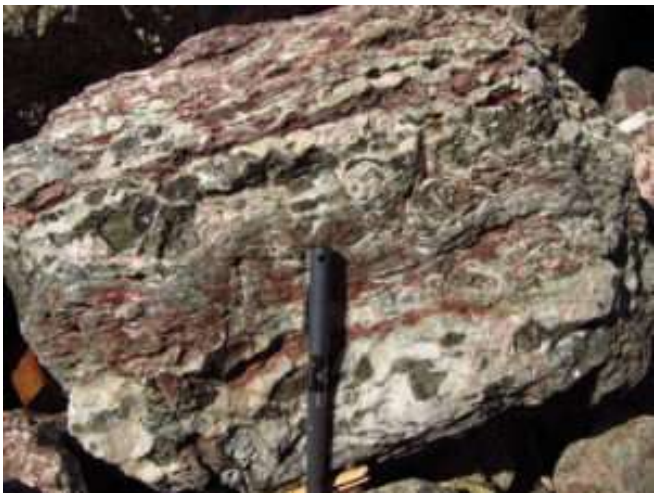
Shear zone in metagranite at the Neves Glacier (Sud-Tirol, Italy). Thanks to the organizers of the EGU Summer School for bringing me there!

In the figure above, a horizontal shear zone crosscuts a metagranite. The difference between the host rocks and the shear zone is striking: the host rock preserves a crystalline magmatic fabric with coarse-grained igneous textured quartz, feldspar, and biotite, whereas in the shear zone shows a completely re-organized mylonitic structure. The shear zone is fine-grained, well foliated, and rich in micas with respect to the surrounding rocks. Fragments of the original igneous rock (called **protolith**) are present within the shear zone. If you look at the transition between the 'undeformed' host and the shear zone, you may notice the presence of a foliation inclined at 45° a few centimeters away from the 'high-strain' shear zone: approaching the shear zone itself, this foliation progressively bends and becomes parallel to it (check out also the interpreted figure, below). This structure is the result of the progressive re-organization of the igneous rock, whose grains rotate, stretch, and recrystallize as the shear zone widens. For structural geologists, this is very valuable: these features are **kinematic indicators** – structures that can reveal us the sense of movement of a shear zone. If you look carefully in the photo above, indeed, you can see that the drag of the foliation is consistent with the rightward displacement of the block at the top (top-to-the-right sense of shear). Because lineations here are subhorizontal, we can tell this was a dextral shear zone.

Metagranites are wonderful, because mylonites are easily visible with respect to the surrounding igneous structures, but shear zones can nucleate in every rock – from metasediments in the crust to peridotites in the mantle – producing beautiful mylonitic structures! What changes with different rock types are the properties of the deformed grains that may exhibit brittle or ductile behavior at different temperature. For example, **quartz** already flows at 300 °C, while **olivine** can be brittle up to 700 °C.



Interpretation of the Neves shear zone, shown above. The foliation (yellow) forms in the metagranite close to the shear zone and it is deflected and parallelized to the mylonitic foliation (center). In the shear zone, the metagranite has been completely transformed to a mylonite.



Mylonitized metagabbro from Cala del Leone (Quercianella, Italy). Unlike metagranites – that typically deform above 300 °C, metagabbros require higher temperatures (> 400 – 500 °C) in order to deform the strong plagioclase and pyroxene grains.

Why are shear zones important?

Understanding shear zones and interpreting their deformation history represent major goals for structural geologists. Fossil shear zones, now exhumed to the surface, hold valuable clues to how mountains formed and plates collided. They are precious 'hard drives' of the deformation mechanisms happening at depths and temperatures that are otherwise completely inaccessible. Studying those structures helps us understand how rocks deform and how strain is distributed through the lithosphere, giving us important clues about how plate tectonics works.

Shear zones also affect our daily lives! Even if shear zone are (generally, not always) aseismic (i.e. do not produce earthquakes), they transport mechanical energy loading shallower faults that have the potential to release energy in the form of destructive earthquakes. Shear zones are also major discontinuities that may act as preferred fluid pathways through the crust, becoming potential traps for strategic metal, rare earths, and other mineralizations.

Further Reading

Sibson (1977). Fault Rocks and Fault Mechanisms.

White et al. (1980). On mylonites in Ductile Shear Zones.

Ramsay (1980). Shear zone geometry: a review.

Gapais (1989). Shear structures within deformed granites: Mechanical and thermal indicators.

Snoke et al. (1998). Fault-related Rocks: A Photographic Atlas.

Carreras (2001). Zooming on Northern Cap de Creus shear zones.

Fossen & Cavalcante (2017). Shear zones – A review.

Mountain Beltway (AGU Blogosphere)

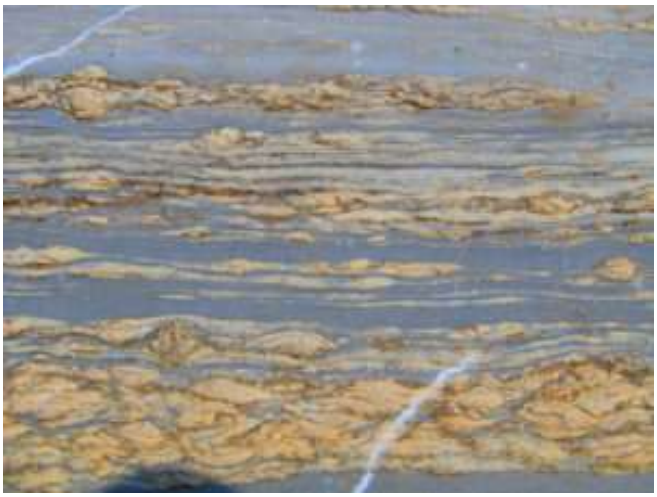
Gallery

When I asked for field photos to write this post, I did not foresee the amount of support coming from the GEO-Twitter community! It is a pity not to show all the beautiful images that you sent to me. Therefore, I hope you will enjoy this gallery of stunning shear zone photographs!

Sheared amphibole-bearing granite with a sigmoidal lozenge of an intermediate intrusive rock. Tibet.

Mylonitized metapellite from Main Central Thrust Shear zone, NW Himalaya.

Strain (and foliation intensity) increases upward in this sheared migmatite from the Ivrea Zone (W Alps, Italy).



Dolomite (yellow) is stronger than calcite (grey) and during deformation it forms the resistant sheared layers in this mylonitic marble from the Apuan Alps (Italy).

Sheared Proterozoic (Iona Group) conglomerate, Uamh nan Calman, Iona (Scotland).

Set of anastomosing dextral and minor sinistral ductile shear zones across schists and pegmatite bodies. Cap de Creus (Catalunya, Spain)

Mylonitic structures in schistose rocks from the Calamita Schists (Island of Elba, Italy).

Ultramafic mylonite from the metamorphic sole of the Dinarides, Albania.

Shear zone in Archean Lewisian gneisses, near Miabhaig, Lewis. Outcrop is about 2m high.

Tiny, localized shear zone in metagabbro, Saxonian Granulite Massif, Germany.

Mylonized Alpujarride metacarbonate, below Veleta, Sierra Nevada (Spain).

Mylonitic metadolomite from the Noonday Fm., Death Valley (California). Field of view is approximately 100 cm.

Set of anastomosing dextral and minor sinistral ductile shear zones across schists and pegmatite bodies. Cap de Creus (Catalunya, Spain).

(EGU Blogs, January 25, 2021, https://blogs.egu.eu/divisions/ts/2021/01/25/features-from-the-field-shear-zones-and-mylonites)

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

Greece: Tunnels and Mining Sites

Web map of Greek tunnels and mining sites. Includes historic tunnels, hydraulic tunnels, road tunnels, railway tunnels and underground mining projects.

In parallel with the Greek Tunnel Locations / Sites highlighted recently by WTC 2023 - Athens by Andreas Benardos and Vassilios Marinos, here is a tool that was developed within a GIS framework that includes a photo of each site and selected details. Link: https://lnkd.in/qAxbpzD The database will continually be updated as information is determined / received.

Nicholas Vlachopoulos / Royal Military College,
https://www.rmcgreenteam.com/

International Society for Soil Mechanics and Geotechnical Engineering

ISSMGE News & Information Circular February 2021
https://www.issmge.org/news/issmge-news-and-information-circular-february-2021

1. 20ICSMGE / 7iYGEC – NEW DATES – MAY 2022

New dates have been confirmed for the conferences in Sydney as follows;

7iYGEC - Friday 29 April-Sunday 1 May 2022

20ICSMGE – Sunday 1 May – Thursday 5 May 2022.

For more information, please visit the conference website (https://icsmge2021.org/ - currently being updated).

2. BULLETIN

The latest edition of the ISSMGE Bulletin (Volume 14, Issue 6, December 2020) is available from the website https://www.issmge.org/publications/issmge-bulletin/vol-14-issue-6-december-20200

3. ISSMGE FOUNDATION

The next deadline for receipt of applications for awards from the ISSMGE Foundation is the 31st May 2021. Click **here** for further information on the ISSMGE Foundation.

4. **NEWS FROM NAUE – WEBINAR**

The next webinar Geosynthetic Clay Liners (GCLs) in comparison to a compacted Clay Liner will take place on Thursday, 11th February at 9:00 CET and will be held by Kent von Maubeuge.

The link for the registration is https://attendee.gotowebinar.com/register/2407574635776422928

5. CONFERENCES

For a listing of all ISSMGE and ISSMGE supported conferences, and full information on all events, including deadlines, please go to the Events page at https://www.issmge.org/events. However, for updated information concerning possible changes due to the coronavirus outbreak (ie. postponements, cancellations, change of deadlines, etc), please refer to that specific event's website.

As might be expected, many events have been rescheduled and we update the Events page whenever we are advised of changes.

The following are events that have been added since the previous Circular:

ISSMGE Events

16TH INTERNATIONAL CONFERENCE ON GEOTECHNICAL ENGINEERING, 23-02-2022 - 24-02-2022 University of Engineering & Technology (UET) Lahore, Pakistan; Language: English; Contact information: Dr. Jahanzaib Israr; Department of Civil Engineering, University of Engineering & Technology Lahore; Phone: +923344132808; Email: 16icge@uet.edu.pk; Website: https://16icge.uet.edu.pk/

204: GEOTECHNICAL ASPECTS OF UNDERGROUND CONSTRUCTION IN SOFT GROUND - TC204 CAMBRIDGE 2022 - 27-06-2022 - 29-06-2022 University of Cambridge, Cambridge, United Kingdom, Language: English; Organiser: University of Cambridge; Contact person: Dr Mohammed Elshafie; Email: me254@cam.ac.uk; Website: https://www.is-cambridge2020.eng.cam.ac.uk

TC306 launches Educational Video "What happens when soil compresses", using best instructional practices

TC306 and its Chair Prof. Marina Pantazidou are pleased to launch an educational video on "What happens when soil compresses" using best instructional practices, and make it available through ISSMGE's Virtual University platform. Specifically:

- The video is segmented in short-duration subsections, each with a descriptive title.

Segmenting a presentation in smaller subsections (recommended 7-15 min) facilitates attendance, and the subsection titles help the audience grasp the logical structure of the webinar/course. The platform interface makes it apparent that the subsections are parts of the same course. Attendees are guided to view them sequentially, while they are free to choose their own viewing order.

- Subsections are accompanied with quizzes of multiple choice questions.

Research evidence has shown that frequent quizzes result in higher learning gains than reviewing. Questions may have a single or multiple correct answers; the number of correct answers may be specified or not (for added challenge). Wrong answers can be accompanied with a short commentary. NOTE: Quizzes are visible only in the "Enroll" mode, not in the "View" mode.

- The presentation slides and transcript are available for download.

The availability of the slides and transcript allow for quick and targeted reviewing of the presentation, which can become cumbersome in a watch-only mode. This feature also facilitates peer review, which will raise the standard of VU content.

- The transcript appears as text next and below the presentation slides.

This feature also facilitates attendance and is particularly helpful for presenters and attendees whose native language is not English.

Watch "What Happens When Soil Compresses" educational video: http://virtualuniversity.issmge.org/courses/course-v1:ISSMGE+SEV101+2020/about

Participating to the Courses of the ISSMGE Virtual University

Kindly note that Pierre Delage sent you the message below:

Dear TC Officers,

As you probably know, the ISSMGE has started to set up a Virtual University (VU) under the leadership of Prof. M. Bouassida, appointed Board member, following one of the points of President Charles Ng's vision on the ISSMGE. As can be seen on the webpage (http://virtualuniversity.issmge.org/), the courses presently embrace eight topics: Earthquake engineering, Foundations, Risk mitigation, Monitoring and Observattional methods, In-Situ Testing, Soil Characterisation, Unsaturated Soil Mechan-ics, Geo-Engineering Education and Geosynthetics. Of course, some of TC members have already been involved in these courses.

It has been suggested, during the last Board meetings, that this series of courses be enlarged based on the competency and knowledge of the TCs and of their members. The Board considered that it would be good that each TC proposes at least two lectures relevant with the scope of the VU. TC officers are then invited to mobilise their members in doing so.

There is no doubt that the content of the VU will be significantly enlarged by your contributions, for the profit of the ISSMGE members and, more largely, the improvement of Geotechnical practice all over the world.

Please send me (pierre.delage@enpc.fr- and also send Prof. M. Bouassida (mounir.bouassida@enit.utm.tn) the titles and speakers of the courses that you will propose.

Thanks for your help,

Best regards,

Prof. Pierre Delage
TOC chair

ISSMGE Time Capsule Project (TCP)

Opportunity/ Context

The coming decades, encompassing the centenary of the ISSMGE (2036), are predicted to bring unprecedented changes in all walks of life, through the underlying shift in world view and attitudes towards digital advances and sustainability considerations, accelerated by the necessary changes in practice and expectations that COVID 19 has brought.

Our opportunity is here and now to bring forward the creation of an entirely **Virtual Time Capsule (VTC)** that brings together and provides a common heritage to all geotechnical engineers.

Vision/ Purpose

This is an exercise that keeps us (ISSMGE)

i. in touch today and provides more continuity to the leadership of ISSMGE
ii. connecting ISSMGE with all of its base, in particular the 90% who are largely silent
iii. providing a vehicle for their rehearsing their voice and expressing their thoughts.

Approach & Organisation

Because of the past, we are here today. The past can be summarised by the following points,

1. What did geotechnical engineering achieve then and what social conditions prompted it?
2. What were the successful achievements of geotechnical engineering?
3. What were the mistakes, and what could not be achieved?
4. Evaluation of the past by future generations; future means the 2030's.

We could consider the past via the following periods:

- Pre-1930's (before ISSMFE was formed) – this would include such historical figures as Coulomb, Rankine, Bell, Fellenius and others, plus Terzaghi's rise to prominence
- The decade of the 1930s
- The decade of the 1940s

- Each decade thereafter, up to the end of the 2010s

Within each period, we could include the following items:

1. The major advances in soil mechanics and the various facets of geotechnical engineering
2. Identification of at least some of the seminal technical papers published within that decade
3. The Presidential addresses, representing contemporary views

There are two further criteria for selection of **VTC** contents;

i. good and poor aspects in development of soil mechanics and geotechnical engineering, including the growth, distribution, and diversity of geotechnical engineers within ISSMGE and how it has changed/changing over the years (to the extent available).

ii. regional geotechnical activities, problems, and consequences including major projects, and serious incidents and lessons learnt

A further aspect can be the role that education played and continues to play in geotechnical engineering. Academia has had a hugely influential role, and this is not always understood.

Implementation & Communication

In the context of the stated vision/ purpose (Item 2.0 above), implementation necessarily involves communication, and communication is part of implementation. We envisage the following targeted communication and implementation means are feasible and worthwhile for this presidential term.

1. **Technical Committees** to be asked to succinctly document the development of their area, most conveniently by decades, focussing on major breakthroughs and why that came about, with collateral material (papers etc) that support their story

2. **Member societies** to be asked to provide material that support and explain the development of geotechnical engineering in their countries, including major failures, as a well as major geotechnical triumphs/ achievements

3. **Corporate Associates** of the ISSMGE, and all **comercial organisations,** be invited to outline what contributions they have made to geotechnical engineering, and projects, with supporting documents

4. **Academic institutions** be invited to present their unique contributions to the advancement of geotechnical engineering, and in particular advances and innovations in geo education that they have championed

5. **Young Members** of the ISSMGE be invited to guess which technical advances we believe should have been already been achieved by 2036? We invite here the most open thinking.

A key part of the implementation & Communication work would be to create an accessible site where geotechnical community at large can view the evolving **VTC**, and respond to a very brief (short) survey to elicit their thoughts and concerns about the contents, and any new insight they have had as a result of viewing the contents of the **VTC**.

Time Frames & Resources

Suggested time frames can be

- September 2020 to January 2021 (5 months) – Preparatory work to get our material all in order, and clarity of tasks and requests

- February 2021 to May 2021 (4 months) - consultations with Technical committees, Member Societies, Corporate Associates, Commercial organisations, Academia, and young members

- June to August 2021 (3months) – consultations/ survey with geotechnical community

- August 2021 (1 month) - Preparations for presentation of **VTC** at the Sydney Conference.

Resources required include

- **support and leadership by members of the Board and BLC chairs**

- access to a **secure and robust** web page (can be ISSMGE page) that allows hosting and viewing of the **VTC**, and takes in responses to survey questions

- There may also be a funding requirement for support by support staff

- Most importantly, continued leadership and work by the **TCP committee**.

ISRM International Society for Rock Mechanics and Rock Engineering

News

www.isrm.net/noticias/?tipo=1&todas=1&show=info

Milton Kanji 1937 -2021 2021-02-12

It is with great sadness that the ISRM informs that Prof. Milton Kanji passed away on 12 February 2021 due to Covid-19. He was active in the ISRM at least since 1974, when he was elected VP for South America, and until very recently, when he was the chairman of the Commission on Soft Rocks until 2019 and co-edited the book "Soft Rock Mechanics and Engineering". Very deservedly, he was appointed a Fellow of the Society in 2013 and in December 2017 he gave an excellent ISRM Online Lecture on "Dam Foundations affected by Geological Aspects".

ISRM initiative to increase the courses available on the website 2021-02-10

Experts were invited to deliver these courses and one of these new courses most recently became available in January 2021 on the ISRM website. We expect to several of these new ISRM video courses, which are in preparation, in our website until April 2021.

New ISRM course on "Prevention methods for Landslides in Rock Masses" by Prof. Zhong-qi YUE 2020-12-28

1st International Youth Scientists Forum for Discontinuous Deformation Analysis (IYSF-DDA) 2020-12-19

2020 ITA Tunnelling Awards winners

Major Project of the Year (over €500M)

John Holland CPB Ghella Joint Venture Tunnelling and Station Excavation Works for the Sydney Metro City & Southwest Project

Sydney Metro is Australia's biggest public transport project. The City & Southwest project aims to extend the Metro North West rail line from Chatswood through to the Sydney CBD and beyond to Sydenhamand Bankstown.

It is Australia's first project to have five tunnel boring machines (TBMs) building tunnels simultaneously including under iconic Sydney Harbour and through the congested underground CBD environment, while roadheaders created some of the largest caverns in Australia.

Many achievements were implemented for this massive projects such as : 2 dives and permanent portal structures, 3 underground mined stations, 1 crossover cavern, 3 open station boxes, 3 shafts and 1 tanked station box structure. Impressive works were also operated with the excavation of 2 twin 15.5km fully lined tunnels between Chatswood and Marrickville with 57 cross passages.

Project of the Year (between €50M and €500M)

Chinatown Station of the Central Subway Program - San Francisco

Chinatown Station is one of three stations for the Central Subway Project, a north-south LRT extension. Chinatown is a vibrant commercial and residential district with the city's highest population density. Chinatown station project was one of the most challenging engineering and underground construction projects in the U.S. due to its setting in narrow streets, historic buildings, numerous utilities and poor ground conditions.

The station's main elements are the Station Platform and Crossover caverns combined. The overall main cavern dimensions are 192m long by 16.7m wide and 13.1m high with an excavated cross section of 202m2, making it one of the largest Conventional Tunneling excavation in poor ground and soil-like materials in the U.S. The main station entrance and service facility are located off street and connected to the platform cavern via a Cross-Cut cavern. This enables the construction of the station cavern in two directions simultaneously, running as many as four operations.

Due to ground variability and the risk of Conventional Tunneling, a pre-support system comprised of grouted steel pipe arch canopies were provided and face bolts were used in the center drift. To protect adjoining buildings, including "the Mandarin Tower" and the historic Presbyterian Church, an instrumentation and monitoring plan was developed using multi-point extensometers, inclinometers, and Total Stationing. Compensation grouting was implemented to maintain the settlement in impacted structures to less than 12mm.

Project of the Year incl. Renovation (up to €50M)

Lower Otta Hydropower Project

Nedre Otta Hydropower Project (Lower Otta HPP) is situated on the Otta river, one of the tributariesto Lågen river that further connects to Glomma, which is the longest river in Norway. The scope of works is the construction of an intake structure with a 200 m2 trash rack area and two intake gates, 10.1 km unlined headrace and tailrace tunnel (90 m2), surge tunnels upstream and downstream, Powerhouse 65,000 m^3 with15,000 m3 concrete works.

The project consists of 11km of tunnels with a cross section up to 90 m^2 (waterway), an underground powerhouse of 65,000 m^3 with 2 Kaplan units (90 m^3/s each)The project was split into multiple construction and supply contracts and coordinated by the Management and Supervision Team from Hafslund-ECO with support of Norconsult AS as the Owners Designer and Technical Advisor.

The project was based on a Virtual Design and Construction (VDC) process where a "digital twin" was established with input from all disciplines and suppliers. The construction was performed directly based on the BIM without production of 2D drawing. The underground works (tunnel and caverns) were preformed in a very efficent manner. Skanska utilized two Atlas Copco XE3 jumbos with 3 booms for the tunnelling works, drilling 5.2 m rounds to 2/8 full cross section. The

loading was done with a 51 ton Cat 988. Transportation of the tunnel muck was performed with Cat 772 trucks with a maximum payload of 51.6 tons. At the maximum they had 6 trucks in operation at the site. In practice, there was one set of dump trucks that served both tunnel fronts. They achieved (slightly better than planned) average production rates 55 m/week with production of up to 68 m/week in some weeks for the headrace and tailrace tunnels with cross section of 90 m^2.

FEDRO's Tunnel Renovation Method – renovation of a non-reinforced primary lining using night shifts while keeping all traffic lanes open during the day

This project consists in the removal of part of primary lining, installation of drainage & sealing systems, final lining with self-compacting concrete, construction of verges incl. drainage, renewal of road surface, installation of electrical equipment.

To secure the availability and usability of the motorway network, the Federal Roads Office (FEDRO) developed new solutions for the renovation of road tunnels while keeping them open to traffic, and initiated an innovative project. Completely replacing the primary lining could not be regarded as a standard solution because the secondary lining could not guarantee stability and the demolition work could endanger road users. The solution that was ultimately considered was to partially remove the primary lining,install drainage and sealing systems and then construct a new final lining.

The stability of the weakened arch could be secured using temporary rock bolts, and traffic diversions would only take place at night when work was being carried out in the tunnel.

The new arch of self-compacting concrete in tunnel T3 was constructed in a single step and is designed solely to provide the necessary stability. To maintain two-lane traffic during the day, aspecial tunnel formwork had to be conceived. For this project, two sealing systems were tested and compared: conventional synthetic sealing membranes and a sprayed sealing system.

Technical Innovation of the year

An Innovative Automated Geological Forward-prospecting Technique Mounted on Hard-rock TBM

An increasing number of hard-rock Tunnel Boring Machines (TBMs) have been utilized for tunneling in the fields of transportation, water conservancy, and mining, etc. However, hard-rock TBM has poor adaptability of adverse geology, such as faults, karst caves and fractured zones. Without identification of unknown geology in advance, TBM tunneling may suffer geo-hazards like water in rush, collapse and large deformation.

For adverse geology like faults, this system was developed as an active-source seismic prospecting system mounted on TBM coupled with a real-time forward-prospecting technique using TBM drilling noise to realize accurate 3D imaging of faults and fractured zones within 120 m ahead, which also fills the international gap of real-time detection while tunneling.

Specifically, the detection system of the proposed IP and seismic methods are all mounted on TBM. Through remote control, automatic data acquisition can be realized within 10 minutes and construction activities of TBM will not be influenced. This prospecting technique has been applied in 21 engineering projects for 1365 times (67.42 km in total) without missing any major disaster sources, which played an important role in TBM tunneling efficiency optimization and safety assurance.

Overcoming the challenge

Chengdu-Guiyang High-speed Railway—Yujingshan Mountain Tunnel Crossing Giant Karst Cave and Underground River

The project takes place in a section of Yujingshan Mountain Tunnel that encounters a giant 1.08 million m karst cave hall and 18km long underground river (on the Chengdu-Guiyang High-speed Railway Line). The major part of the project was the construction of a tunnel crossing a giant karst cave and underground river.

With a designed speed of 250km/h and a length of 515km, the Chengdu-Guiyang High-speed Rail Project (CG HSR) is a key part of the "Lanzhou (Xining)-Guangzhou Corridor", and one of the 16main high-speed railways (8 horizontal lines & 8 vertical lines) in China. With a height of 50m ~ 120m, the domed cave hall is located 60m below the ground. It is 95m inlength (in the rail line direction) and 230m in width. In terms of area, it is equivalent to three standard football pitches.

The project faces four major challenges as it crosses the giant cave and underground river system rarely seen anywhere

else in the world:

- With the risk of cave wall collapse, the first challenge is to ensure the safety of construction personnel and equipment in the cave.

- With the overhanging rail line and the unstable deposition at the bottom of the cave, the second challenge is to determine what kind of engineering structure should be adopted to cross the cave hall safely and economically.

- With a high and giant karst cave and limited working faces for tunnel construction, the third challenge is to complete the project on time.

- With the need of protecting environment and drinking water resources from polluting, the fourth challenge is to maintain the balance of the existing underground water network and the original ecosystem.

Several solutions were set up: design and construction methods to avoid project interruption/pause, large-volume karst cave backfill technology and the "tunnel + bridge" integrated structure, Construction technology innovation to ensure construction safety and meet the deadline and layered groundwater discharge system is designed: underground river is discharged through diversion channels; fissure water seeps from rock layer around the cave, and rainy-season floods are discharged from the spillway.

Oddities of the underground

Tunneling in the service of archaeology

Hidden beneath the present-day historical center of Jerusalem lies a city built more than 3,000 years ago. Every year it attracts more than half a million visitors captivated by its history. The entire extent of the archaeological site has not yet been fully explored as the excavation works reveal it. Excavations are already taking place for the last past years, revealing important and significant findings of the ancient Hordus-Passage leading to the ancient Temple.

Tunnel design and building expertise in soft grounds and archaeological fill is required in order toproceed with the excavations and make the site accessible to the public. Excavation is carried outunderground, manually, using steel ribs and steel plates as temporary and permanent support. The sensitive environment demands great dexterity and flexibility. Unexpected finds can lead tosudden changes in the direction of excavation, often accompanied by low overburden heights and difficult ground conditions. Due to site complexity derived from small excavation area and risks of shallow tunneling in urbanarea, special excavation technologies are executed, such as custom-made drill machines adapted tosmall spaces.In addition to that, special measures are to be taken in order to consider the archaeological findings and to protect them during excavation. Unlike conventional excavation in which the muck is being moved away, the nature of this project is to keep the muck for further research by scientists.

Innovative and Contributing Underground Spaces

Union Square Market Street Station - Battered Drilled Shafts as Permanent Ground Support

The Union Square Market Street Station (UMS) is an underground station that is being constructed as a part of the Central Subway Project in San Francisco, California. The entire project is a 1.7-mile-long subway extension with three underground stations and one surface station. The Project will improve public transportation by extending the Muni Metro T Third Line through South of Market District, Union Square and Chinatown. The south entrance will be integrated with the existing BART/MUNI Powell Street Station, providing a direct connection between the two transit lines. To the north, the main entrance will be at the south-east corner of Union Square on Geary Street.

A portion of the famous Union Square Garage and Plaza will be repurposed to house the main points of egress as well as two emergency ventilation shafts. The station is approximately 950 feet long. Its overall configuration is divided into three areas: the North Concourse, the Platform and the South Concourse. The North Concourse is about 200 feet long and 55 feet below the roadway. The Platform is approximately 400 feet long and ranges in depth from 90 feet to 100 feet. The South Concourse is about 250 feet long along Stockton Street and another 100 feet as it wraps along Ellis Street. The depth ranges from about 20 to 30 feet as it ascends north.

Young Tunneller of the year

Josh Barry

Josh started his career at Aurecon as a student engineer in Melbourne, Australia, in 2007. He had recently returned from an exchange in Canada at the University of Waterloo, where he was enthused by the area of geotechnical engineering.

This passion was furthered through a 12-week work experience placement at Aurecon, and it wasn't long before that work experience led to a full-timerole. But it was a move to Hong Kong in 2011 where Josh really began to step up and take on challenges beyond his experience level, including the South Island Line, which really formed the base of his career and got him excited about developing his future in tunnelling.

In 2016, Josh moved to Bangkok where he has gone on to create and lead Aurecon's first tunnel team in Thailand. Some of the major challenges that Josh has faced are related to spending his career in three very different locations (Melbourne, Hong Kong and Bangkok).

News - ITA Activities

11 February 2021 **World Tunnel Congress 2023 in Athens**

18 February 2021 **Lunchtime lecture series #2**

Scooped by ITA-AITES #36, 2 February 2021

- Bullet Train: Undersea tunnel! Here is latest news update on Mumbai-Ahmedabad High Speed Rail | India
- Go-ahead for £170m Somerset A303 dualling | UK
- Big data spurs autonomous tunnelling - ASME
- Serbia to launch first line of Belgrade metro in 2028
- Western Harbour Tunnel gets go ahead but locals say NSW Government brushed off their concerns | Australia
- Rare Roman relics unearthed in Rome subway construction | Italy
- Estonia, Finland Undersea Rail Tunnel talks may revive Chinese-backed deal
- New station for City Rail Link taking shape below Karangahape Rd | New Zealand
- HNTB selected by SBCTA for Ontario Airport tunnel project | United States of America
- Istanbul: Basaksehir Kayasehir metro line will be opening end of the year | Turkey
- Elon Musk says tunnels under Miami could solve traffic problems | United States of America
- Biden administration expresses support for Gateway Tunnel | United States of America

Scooped by ITA-AITES #37, 16 February 2021

Rail bosses plan to build Northern Ireland to Scotland tunnel | UK

Metro 3: Over 50 km of tunnelling works completed | India

Watch: Comparing tunnelling progress and solutions on Tideway's different sections | UK

Rail plan would put 16-mile tunnel under Long Island Sound | United states of America

Deployment of 25 tunnel-boring machines signals big push for subway completion | Republic of the Philippines

Hidden Underground: How One Kansas Town is Key in Preserving Movie Industry's History | United States of America

Metro Line 3 tunnel will be 50 meters under Canal | Panama

Elon Musk thinks he can build a Miami tunnel for just $30 million | United States of America

Norway's massive Rogfast Tunnel project

Work on Zojila Tunnel continues amid freezing temperatures, snowfall | India

WestConnex makes strong progress | Australia

Work starts on 18-km-long Fehmarnbelt tunnel linking Germany and Denmark

Email: communication@ita-aites.org

ITACET Foundation

Foundation for Education and Training on Tunnelling and Underground Space Use

The following training programmes have been delayed by the Covid-19 pandemic, but preparation is still ongoing concerning the date and the mode of the session (online/in-person):

China (Tongji University): **"Tunnelling 4.0 and Intelligent Construction"**

Switzerland: **"TBM Pilot training"**

Brazil: **"Innovations in Tunnelling"**

Chile: **"Mechanized tunnelling and shafts"**

Colombia: **"Mechanized Tunnelling"**

India: **"Structural use of fibre reinforced concrete in precast segments"**

Mexico: **"Underground Urban Facilities"**

Thailand: **"Contractual practices"**

BRITISH TUNNELLING SOCIETY

Joint BTS/MinSouth February 2021 Meeting : North Yorks Polyhalite Project Mineral Transport System
http://www.britishtunnelling.org.uk

Speakers: Craig Sewell & **Jason Fawcett** – Strabag

Since 2019, Strabag have been undertaking construction of the Mineral Transport System for the North Yorks Polyhalite Project. This includes a 37km long segmentally lined tunnel and a 370m deep shaft at Lockwood Beck

The presentation will cover the extensive work being undertaken on the project and an update on the progress of the project to date.

Note: Lecture and the Q&A will be broadcasted live on YouTube https://youtu.be/K6jky336ooA.

BTS March 2021 Meeting
Werrington Grade Separation - Curved Box Jack
http://www.britishtunnelling.org.uk

Speaker: Matt Hadden, Senior Project Manager, Morgan Sindall Infrastructure

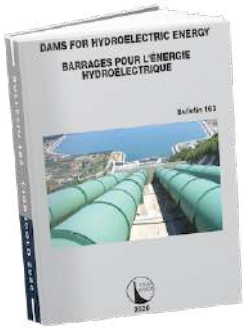
A diver-under structure was required to take two railway lines beneath the East Coast Main Line, removing a key bottleneck on the network. A 150m long, 8m high, 11.5m wide, 750m radius curved reinforced concrete box weighing 11,000T was constructed offline and then jacked 165m into position during a 9-day partial closure of the main line.

In this lecture, Matt Hadden will discuss the engineering challenges faced in the construction of the scheme.

Note: Lecture and the Q&A will be broadcasted live on YouTube https://youtu.be/l6UKpfRpv5o.

International Commission on Large Dams

2 New Bulletins are published
http://lxgm.mj.am/nl/lxgm/ut2jv.html



Bulletin 163:

Dams for Hydroelectric energy

The Bulletin is intended as a general document aimed at a wide technical audience involved with or affected by hydropower. Basic background data and some statistics are presented, with specific reference to hydro-electricity production, hydropower dams, hydropower plants, in operation or under construction.

Key aspects of hydropower are discussed. Data are presented about typical capital and both internal and external operating costs. Environmental and social impacts are discussed, and reference is made to the impact reservoirs have on greenhouse gas emissions.

A section is dedicated to the exploitation of tidal energy by means of barrage systems. The current extent of hydropower development and the influence of policies aimed to favour the development of renewable energies are also discussed. Reference sources of information, on hydropower in general and interesting casehistories, are provided.

Bulletin 177:

Roller-Compacted Concrete Dams

ICOLD Bulletin 177 'Roller-Compacted Concrete Dams' presents the state-of-the-art on roller-compacted concrete technology for dams, incorporating the advances of the RCC technology for dams over the last 15 years since the previous Bulletin on the topic was released in 2003. Hence, the present Bulletin supersedes ICOLD Bulletin 126 (published in 2003) and ICOLD Bulletin 75 (published in 1989).

ICOLD Bulletin 177 'Roller-Compacted Concrete Dams' presents the state-of-the-art on roller-compacted concrete technology for dams, incorporating the advances of the RCC technology for dams over the last 15 years since the previous Bulletin on the topic was released in 2003. Bulletin 177 supersedes Bulletin 126 (2003) and Bulletin 75 (1989). While roller-compacted concrete technology could have still been considered a new technology in 2003, Roller Roller-compaction has become the standard approach for large concrete gravity dams.

This Bulletin addresses all aspects of the planning, design, construction, and performance of RCC in dams. Mixture proportioning and quality control are discussed, and a comprehensive listing of references is included. Many aspects of RCC in dams have become better understood since the publication of Bulletin 126 and the present Bulletin includes more comprehensive information particularly in relation to design, mixture proportioning and construction. It has further been possible to highlight more definitively the requirements of successful RCC dams, as well as the pitfalls and difficulties that can be associated with RCC dam design and construction.

Institution of Civil Engineers

Top five open access papers

Open access papers making an impact in policy, industry and research.

We recently reviewed the most downloaded eBooks and journal papers of 2020. Unsurprisingly, a few open access papers made the list! More surprisingly, our most downloaded eBook was also open access.

These most-downloaded open access papers show some of the impacts that your work could have. Let us count them down and take a closer look…

5

Ground characterisation for PISA pile testing and analysis

Published in 2020, this paper is already making a splash with 17 citations so far. It is part of a *Géotechnique* open access themed issue on the geotechnical design for offshore wind

turbine monopiles by the PISA project. The industry-led PISA (Pile–Soil Analysis) Project, administered through the Carbon Trust's Offshore Wind Accelerator, developed new methods to accurately capture the detailed monopile soil–structure interaction behaviour, facilitating site-specific and turbine support structure-specific optimisation.

4

Engineering future liveable, resilient, sustainable cities using foresight

This paper is based on data derived from a portfolio of research programmes, the University of Birmingham's 2014 Future Urban Living report and the findings from the UK government's Foresight Future of Cities project. It has been cited 29 times since its publication in 2018. It shows how civil engineers can build better cities through a deeper understanding of the future benefits, resilience and value of their proposed urban infrastructure solutions.

3

The engineering properties of glacial tills

This paper is from our Gold open access journal *Geotechnical Research,* which publishes coverage of all aspects of modern geotechnics. The paper provides an overview of the formation of subglacial tills and the impact that it has on their characteristics, and techniques that could be used to generate design properties.

2

Transport poverty and its adverse social consequences

This paper from *Transport* has been cited 80 times since its publication at the end of 2016, making it the journal's most cited paper. It was published in an open access themed issue on transport and global poverty. Equality and the sustainable development goals remain a key concern for civil and environmental engineers. As such, the paper also has an Altmetric score of 43 and has been mentioned in six transport policy documents.

1

Circular economy in construction: current awareness, challenges and enablers

This paper was published in a 2017 themed issue of *Waste and Resource Management* on circular economy in the built environment. It is the journal's most cited paper of all time with 83 citations. 85% of its citations have been received in the past two years. In fact, they have increased since our most downloaded blog last month! Utilising the results from a survey and a follow-up workshop, the paper provides an analysis of an industrywide perspective of circular economy awareness, challenges and enablers.

We have a number of open access options available to suit your needs and those of your funders. As well as Gold and Green open access for your paper, we can also arrange for whole issues or books to be published this way.

(Caitlin Flint, 16 February 2021, https://www.icevirtuallibrary.com/page/ice-news/134-best-open-access)

Géotechnique, **Volume 70, Issue 11**: Themed issue on geotechnical design for offshore wind turbine monopiles (November, 2020, pp. 943-1082).

Editorial: geotechnical design for offshore wind turbine monopiles, Byron W. Byrne, 70(11), pp. 943–944

Ground characterisation for PISA pile testing and analysis, Lidija Zdravković, Richard J. Jardine, David M. G. Taborda, David Abadias, Harvey J. Burd, Byron W. Byrne, Kenneth G. Gavin, Guy T. Houlsby, David J. P. Igoe, Tingfa Liu, Christopher M. Martin, Ross A. McAdam, Alastair Muir Wood, David M. Potts, Jesper Skov Gretlund, Emil Ushev, 70(11), pp. 945–960

New data analysis methods for instrumented medium-scale monopile field tests, Harvey J. Burd, William J. A. P. Beuckelaers, Byron W. Byrne, Kenneth G. Gavin, Guy T. Houlsby, David J. P. Igoe, Richard J. Jardine, Christopher M. Martin, Ross A. McAdam, Alastair Muir Wood, David M. Potts, Jesper Skov Gretlund, David M. G. Taborda, Lidija Zdravković, 70(11), pp. 961–969

Monotonic laterally loaded pile testing in a stiff glacial clay till at Cowden, Byron W. Byrne, Ross A. McAdam, Harvey J. Burd, William J. A. P. Beuckelaers, Kenneth G. Gavin, Guy T. Houlsby, David J. P. Igoe, Richard J. Jardine, Christopher M. Martin, Alastair Muir Wood, David M. Potts, Jesper Skov Gretlund, David M. G. Taborda, Lidija Zdravković, 70(11), pp. 970–985

Monotonic laterally loaded pile testing in a dense marine sand at Dunkirk, Ross A. McAdam, Byron W. Byrne, Guy T. Houlsby, William J. A. P. Beuckelaers, Harvey J. Burd, Kenneth G. Gavin, David J. P. Igoe, Richard J. Jardine, Christopher M. Martin, Alastair Muir Wood, David M. Potts, Jesper Skov Gretlund, David M. G. Taborda, Lidija Zdravković, 70(11), pp. 986–998

Finite-element modelling of laterally loaded piles in a stiff glacial clay till at Cowden, Lidija Zdravković, David M. G. Taborda, David M. Potts, David Abadias, Harvey J. Burd, Byron W. Byrne, Kenneth G. Gavin, Guy T. Houlsby, Richard J. Jardine, Christopher M. Martin, Ross A. McAdam, Emil Ushev, 70(11), pp. 999–1013

Finite-element modelling of laterally loaded piles in a dense marine sand at Dunkirk, David M. G. Taborda, Lidija Zdravković, David M. Potts, Harvey J. Burd, Byron W. Byrne, Kenneth G. Gavin, Guy T. Houlsby, Richard J. Jardine, Tingfa Liu, Christopher M. Martin, Ross A. McAdam, 70(11), pp. 1014–1029

PISA design model for monopiles for offshore wind turbines: application to a stiff glacial clay till, Byron W. Byrne, Guy T. Houlsby, Harvey J. Burd, Kenneth G. Gavin, David J. P. Igoe, Richard J. Jardine, Christopher M. Martin, Ross A. McAdam, David M. Potts, David M. G. Taborda, Lidija Zdravković, 70(11), pp. 1030–1047

PISA design model for monopiles for offshore wind turbines: application to a marine sand, Harvey J. Burd, David M. G. Taborda, Lidija Zdravković, Christelle N. Abadie, Byron W. Byrne, Guy T. Houlsby, Kenneth G. Gavin, David J. P. Igoe, Richard J. Jardine, Christopher M. Martin, Ross A. McAdam, Antonio M. G. Pedro, David M. Potts, 70(11), pp. 1048–1066

Application of the PISA design model to monopiles embedded in layered soils, Harvey J. Burd, Christelle N. Abadie, Byron W. Byrne, Guy T. Houlsby, Christopher M. Martin, Ross A. McAdam, Richard J. Jardine, Antonio M. G. Pedro, David M. Potts, David M. G. Taborda, Lidija Zdravković, Miguel Pacheco Andrade, 70(11), pp. 1067–1082

(https://www.icevirtuallibrary.com/toc/jgeot/70/11)

ΔΙΑΚΡΙΣΕΙΣ ΕΛΛΗΝΩΝ ΓΕΩΤΕΧΝΙΚΩΝ ΜΗΧΑΝΙΚΩΝ

Συμμετοχή του Δρ. Χάρη Σαρόγλου στη σειρά του National Geographic με τίτλο "Europe from Above"
In Pictures: Intimate perspectives on Europe revealed in hypnotic new series

Europe From Above returns to **National Geographic** for a second season – bringing its marriage of dizzying perspectives and storytelling to some of the continent's most iconic locations.

SOME of the images take a moment to connect: A mosaic of tiny, intricate tiles on arid ground becomes hundreds – thousands – of artisan Turkish carpets, laid out to dry in the sun. Concentric stud marks in the landscape become elegantly swept bales of a harvested crop. Stacks of matchsticks are in fact felled trees; a seemingly industrial sprawl of scaffold and cranes takes shape into a huge archaeological restoration. Look close and in all, tiny figures move, going about their business as usual. It's us, the viewers, that watch from a novel – and illuminating – vantage point: above.

It's to this privileged angle to which viewers will be returning to as the second series of *Europe from Above* returns to *National Geographic* on 14 February – and at a time when for many, armchair travel couldn't be more welcome. (*Find out how to watch here*.)

Ο Δρ. Χάρη Σαρόγλου συμμετείχε σο επεισόδιο που έχει θέμα την Ελλάδα και η συμμετοχή του αφορούσε στην Διώρυγα της Κορίνθου.

Το trailer της σειράς είναι:
https://www.youtube.com/watch?v=MMLSzwcKzNw

Greece: a dizzying view of the infamous Corinth Canal, which links the Ionian and Aegean seas – and where cruise ships, led by pilot tugs, negotiate a perilous strait with sometimes just 6 feet of clearance.

https://www.nationalgeographic.co.uk/europe-from-above-2

«Η Ευρώπη από Ψηλά»

Με «άρωμα» Ελλάδας ο νέος κύκλος της σειράς ντοκιμαντέρ του National Geographic

Με ένα επεισόδιο αφιερωμένο στην Ελλάδα «ανοίγει» απόψε ο νέος κύκλος της σειράς ντοκιμαντέρ «Η Ευρώπη από Ψηλά» του National Geographic, που θα «ταξιδέψει» επίσης τους τηλεθεατές σε Γαλλία, Ουγγαρία, Σουηδία, Φινλανδία και Τουρκία.

Το σημερινό επεισόδιο για την Ελλάδα, που θα προβληθεί στις 9 το βράδυ, θα περιηγηθεί σε Όλυμπο, Αθήνα, Βέροια, Διακοπτό, Λευκάδα, Επίδαυρο και Μετέωρα. «Στην Αθήνα, ο εμβληματικός ναός του Παρθενώνα, το αριστούργημα μηχανικής, αρχιτεκτονικής και γλυπτικής, στέκεται ακέραιος για πάνω από 2500 χρόνια. Με την πάροδο των ετών, έχει υποστεί καταστροφές από σεισμούς, λεηλασίες και πολέμους με αποτέλεσμα σήμερα να χρήζει εργασιών αποκατάστασης. Μέσα από εναέρια πλάνα, παρακολουθούμε την επιχείρηση, καθώς ανυψώνονται και επανατοποθετούνται μάρμαρα 12 τόνων με απόλυτη ακρίβεια», όπως αναφέρει σε ανακοίνωσή του το National Geographic.

«Επίσης», συνεχίζει, «η Ελλάδα βρίσκεται ανάμεσα στις χώρες που αντιμετωπίζουν τη χειρότερη θαλάσσια ρύπανση στον κό-

σμο. Στο νησί της Λευκάδας, οι ντόπιοι κάνουν μεγάλη προσπάθεια για να αντιμετωπίσουν την κατάσταση, καθώς ο βυθός της θάλασσας μοιάζει με χώρο υγειονομικής ταφής απορριμμάτων.

Για πρώτη φορά ταξιδεύουμε πάνω από τα 20 μοναστήρια στα Μετέωρα, αλλά και το πιο βαθύ τεχνητό κανάλι του κόσμου, τη Διώρυγα της Κορίνθου. Το οπτικό ταξίδι συνεχίζει ακολουθώντας από ψηλά τη διαδρομή απαράμιλλης ομορφιάς του Οδοντωτού σιδηρόδρομου στο Διακοπτό Καλαβρύτων, έως τις ροζ κοιλάδες με τις ανθισμένες ροδακινιές στη Βέροια. Από το πορτρέτο της Ελλάδας, δεν θα μπορούσε να λείπει το σημείο που το βαθύ μπλε σμίγει με το απόλυτο λευκό, η κορυφή του Ολύμπου».

Στο νέο κύκλο της σειράς ντοκιμαντέρ «Η Ευρώπη από Ψηλά», οι τηλεθεατές θα γνωρίσουν διάσημα μνημεία όπως ο Παρθενώνας στην Ελλάδα, αλλά θα έχουν και την ευκαιρία, μέσα από τα επόμενα επεισόδια, να εξερευνήσουν τη μεγαλύτερη φάρμα στον κόσμο που βρίσκεται στην ταράτσα ενός κτηρίου στο Παρίσι, να γίνουν μάρτυρες μιας σχεδίας 12 χιλιάδων τόνων στη Φινλανδία, πριν ξεκινήσει το πλωτό της ταξίδι 270χλμ, να γνωρίσουν τα πανύψηλα Ale Stones της Σουηδίας και το μεγαλύτερο παγοδρόμιο στο πάρκο της Βουδαπέστης καθώς και να δουν εικόνες από την κατασκευή της γέφυρας Cannakale στην Τουρκία.

Το επεισόδιο για τη Γαλλία έχει προγραμματιστεί για τις 22/2, για την Ουγγαρία 1/3, τη Σουηδία 8/3, τη Φινλανδία 15/3 και την Τουρκία 22/3 (κοινή ώρα έναρξης, 21:00).

Το National Geographic είναι διαθέσιμο στην Ελλάδα μέσω Cosmote TV, Nova, Vodafone TV, Wind Vision.

(ΝΑΥΤΕΜΠΟΡΙΚΗ, 15 Φεβρουαρίου 2021, https://www.naftemporiki.gr/story/1692900/i-europi-apo-psila)

ΠΡΟΣΦΟΡΕΣ - ΠΡΟΚΗΡΥΞΕΙΣ ΘΕΣΕΩΝ ΓΙΑ ΓΕΩΤΕΧΝΙΚΟΥΣ ΜΗΧΑΝΙΚΟΥΣ

University of Nottingham
Nottingham Centre for Geomechanics (NCG)

Funded PhD Opportunities at Nottingham Centre for Geomechanics (NCG)

1. "Utilization of Sustainable Grouting Alternatives to Fly Ash in Grouting Applications"
   Apply here: https://lnkd.in/dcpUzbU

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3. "Characterization of Pile Driving Induced Ground Motions"
   Apply here: https://lnkd.in/ePECz2C

Informal contact: Dr Athina Grizi A.Grizi@nottingham.ac.uk
Due to funding limitations, the opportunities are restricted to UK/EU applicants

#Research #Piles #RiskManagement #Structures #Grouting #Geotechnics

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

Για τις παλαιότερες καταχωρήσεις περισσότερες πληροφορίες μπορούν να αναζητηθούν στα προηγούμενα τεύχη του «περιοδικού» και στις παρατιθέμενες ιστοσελίδες.

Λόγω της πανδημίας του κορωνοϊού, υπάρχουν αλλαγές είτε στον τρόπο διεξαγωγής των συνεδρίων (με φυσική παρουσία ή virtual), είτε των ημερομηνιών διεξαγωγής κάποιων συνεδρίων. Συνιστάται να ελέγχετε την ημερομηνία διεξαγωγής απ' ευθείας στον ιστότοπο του συνεδρίου.

Η Συμβολή των Ερευνητικών Φορέων της Χώρας στη Διαχείριση Κινδύνων και Κρίσεων
18 και 19 Μαρτίου 2021, Διαδικτυακά
www.edcm.edu.gr/en/hdrrf/2021

Το χρονικό διάστημα που μεσολάβησε από τη διοργάνωση του **3ου Επιστημονικού Forum για τη Μείωση Διακινδύνευσης από Καταστροφές στην Ελλάδα**, το **Μάρτιο του 2020** έως τώρα, χαρακτηρίστηκε από την εκδήλωση πρωτόγνωρων κινδύνων και κρίσεων που έπληξαν, όχι μόνο τον ελλαδικό, αλλά και τον παγκόσμιο χώρο.

Βιώνουμε σίγουρα μία νέα εποχή, στην οποία περισσότερο από ποτέ στο παρελθόν, επιβάλλεται η ανάγκη για την όσο το δυνατόν πληρέστερη διαχείριση των κινδύνων και κρίσεων με στόχο τον περιορισμό των επιπτώσεων.

Μετά την εξαιρετική απήχηση που είχαν οι συναντήσεις που προηγήθηκαν, διοργανώνουμε το **4ο Forum** με θέμα "**Η Συμβολή των Ερευνητικών Φορέων της Χώρας στη Διαχείριση Κινδύνων και Κρίσεων**", αναλαμβάνοντας την πρωτοβουλία της ευρείας διάχυσης των επιστημονικών εξελίξεων, της τεχνογνωσίας και της εμπειρίας που αποκτήθηκε.

Η συνάντηση είναι ανοιχτή, καθώς επιδιώκεται η διασύνδεση και η συνεργασία μεταξύ των τριών πυλώνων, της επιστημονικής κοινότητας, των επιχειρησιακών φορέων και της κοινωνίας, ως αναγκαία προϋπόθεση για μια επιτυχημένη και αποτελεσματική διαχείριση.

Το 4ο Επιστημονικό Forum για τη Μείωση της Διακινδύνευσης από Καταστροφές θα πραγματοποιηθεί στις **18 και 19 Μαρτίου** 2021, λόγω των ειδικών συνθηκών **διαδικτυακά** και συνδιοργανώνεται από το **ΠΜΣ "Στρατηγικές Διαχείρισης Περιβάλλοντος, Καταστροφών και Κρίσεων"**, το **Τμήμα Γεωλογίας και Γεωπεριβάλλοντος** και το **Κέντρο Αριστείας Διαχείρισης Καταστροφών και Κρίσεων** του **Εθνικού & Καποδιστριακού Πανεπιστημίου Αθηνών**.

Στο Forum καλούνται να συμμετέχουν εκπρόσωποι από Πανεπιστημιακά Ιδρύματα, Ερευνητικά Κέντρα, Επιχειρησιακούς Φορείς, αλλά και Υπηρεσίες του ευρύτερου Δημόσιου Τομέα που σχετίζονται με τη διαχείριση κινδύνων και κρίσεων, παρουσιάζοντας τα νέα επιστημονικά, τεχνολογικά και επιχειρησιακά δεδομένα, τις δράσεις και εξελίξεις στο χώρο και τις καλές πρακτικές στη διαχείριση, ως συλλογική εργασία του κάθε Φορέα.

International Conference on Challenges and Achievements in Geotechnical Engineering, 31.03.2021 – 02.04.2021, Tirana, Albania, Erdi Myftaraga, emy@greengeotechnics.com

Second International Conference on Geotechnical Engineering - Iraq 2021, 5-6 April 2021, Akre (Aqrah), Duhok, Iraq, http://ocs.uobaghdad.edu.iq/index.php/icgeotecheng/icgte

Virtual Rocscience International Conference on Numerical Modelling "The Evolution of Geotech: 25 Years of Innovation", April 20th - 21st, 2021, www.rocscience.com/learning/rocscience-conference

2nd Vietnam Symposium on Advances in Offshore Engineering – Sustsainable Energy & Marine Planning, 22-24 April 2021, Ho Chi Minh City, Vietnam, https://vsoe2021.sciences-conf.org

16th International Conference of the International Association for Computer Methods and Advances in Geomechanics – IACMAG - CHALLENGES and INNOVATIONS in GEOMECHANICS, 03-05-2021, Torino, Italy, www.symposium.it/en/events/2020/16th-international-conference-of-iacmag?navbar=1

UNIVERSIDAD NACIONAL DE COLOMBIA

9th International Symposium on Geomechanics
ISRM Specialized Conference
"Applied Geomechanics in Proactive Designs: Opportunities, Challenges and Security"
Virtual, 3 - 6 May, 2021, Medellin, Colombia
https://minas.medellin.unal.edu.co/gruposdeinvestigacion/giga/en/symposium-9/about-symposium.html

The Geomechanics Symposium is an international academic event that has been held every two years since 2004, and becomes an opportunity to analyze the main challenges and current issues of geomechanics in the oil industry. This particular version addresses geomechanics as part of a proactive design process that seeks to exploit the benefits and manage the negative impacts of extractive oil and gas operations.

Objective of the event

The aim of the event is to promote a space for the divulgation

of knowledge and discussion of topics related to geomechanics, in which can interact academic specialists and representatives of the oil industry, national and foreign, oriented to face the main challenges of geomechanics in the exploration and exploitation of oil reservoirs.

Target audience

The target audience of the event are: Petroleum, geologist, and civil engineers and students; researchers; professional of related areas of reservoirs engineering who are developing topics about geomechanics of reservoirs in one of the thematic lines.

Topics

- Geomechanical issues in Brown fields.
- Geomechanics on heavy oil reservoirs and thermal recovery.
- Unconventional reservoirs geomechanics.
- Wellbore stability and integrity.
- Hydraulic fracturing.
- Sand production: prediction, quantification, management and phenomena associated modeling.
- Caprock integrity.
- Geomechanical damage.
- Naturally fractured reservoirs.
- Geomechanics related to fluid disposal activities in the subsoil: water, gases, CO_2, etc.
- Geomechanical reservoir management.
- Geomechanical laboratory tests.
- Emerging technologies applied to geomechanics

Organizer: Sociedad Colombiana de Geotecnia and Universidad Nacional de Colombia

Telephone: + 57 4 425 5146

E-mail: gaalzate@unal.edu.co

ATS 2020 AUSTRALASIA TUNNELLING CONFERENCE, 10th – 13th May 2021, Melbourne, Australia, www.ats2020.com.au

TISOLS Tenth International Symposium on Land Subsidence, Living with Subsidence, 17-21 May 2021, Delft - Gouda, the Netherlands, www.tisols2020.org/tisols2020

Virtual 2020 CHICAGO ICTG International Conference on Transportation Geotechnics, May 23 - 26, 2021, Chicago, Illinois, USA, http://conferences.illinois.edu/ICTG2020

Fifth International Conference on New Developments in Soil Mechanics and Geotechnical Engineering, 27 – 29 May 2021, Nicosia, Northern Cyprus https://zm2020.neu.edu.tr/

2021 ICOLD MARSEILLE - ICOLD 27th Congress - 89th Annual Meeting Sharing Water: Multipurpose of Reservoirs and Innovations, 4 - 11 June 2021, Marseille, France, https://cigb-icold2021.fr/en/

International Airfield and Highway Pavements Conference, June 6-9, 2021, Austin, Texas, USA, www.pavementsconference.org

MSL 2021 The 1st Mediterranean Symposium on Landslides SLOPE STABILITY PROBLEMS IN STIFF CLAYS AND FLYSCH FORMATIONS, 7-9 June 2021, Naples, Italy, https://medsymplandslides.wixsite.com/msl2021

ДГМ MAG ДРУШТВО ЗА ГЕОТЕХНИКА НА МАКЕДОНИЈА MACEDONIAN ASSOCIATION FOR GEOTECHNICS

5th Symposium of the Macedonian Association for Geotechnics
The problems associated with soft rocks in rock engineering
an ISRM Specialized Conference
https://mag.net.mk/v-mag-symposium-28-30-5-2020

The Fifth MAG Symposium is organized with a goal to familiarize the members of the Association and the general expert and scientific public in the country and the region with the most recent findings in the field of geotechnics, as well to exchange knowledge and experiences gained through the application of field, empirical, theoretical, experimental, numerical and combined methods in solving problems in this area. This symposium would also serve as an opportunity for making closer connections between local, regional and international experts. To this end, MAG has already obtained several eminent lecturers and guests from ISRM as prof. Reşat Ulusay (Turkey) – President of the ISRM, the doyen Nick Barton (England/Norway), prof. Anna Maria Ferrero (Italy) – former secretary of the Eurocode 7 Implementation Group in rock engineering, prof. emeritus Heinz Brandl (Austria) – holder of Medal of Merits for Macedonia, the prominent professor Boris Jeremic (USA/Serbia), prof. Milorad Jovanovski – national expert on rock mechanics, Eda Freitas de Quadros – past president of ISRM, etc.

The Symposium is postponed and will take place in the period 10-12.06.2021, at the Metropol Hotel in Ohrid.

TOPICS

The main topic of the Symposium will be "The problems associated with soft rocks in rock engineering", which will include papers prepared in following areas:

1. Geotechnical aspects in urban areas and infrastructure (dams, roads, railways, tunnels, underground structures, mines, nuclear power plants, etc.)
2. Laboratory and field geotechnical testing and investigation (ISO CEN, laboratory tests, in-situ investigation and testing – CPT, dilatometers, geophysical…)
3. Geotechnical modeling of soils and rocks (numerical, physical, GIS, BIM, remote detection)
4. Assessment and reduction of geo-hazards (terrain instabilities, retaining structures, improvement methods, etc.)
5. Eurocodes and relevant geotechnical regulation (technical regulation, challenges to the implementation of Eurocodes 7 and 8, national annexes)
6. Earthquake geotechnical engineering (influence of local conditions, seismic zoning of the terrain, liquefaction, lessons learned after recent earthquakes)

7. Geotechnics and achievements in support of a sustainable society (environmental protection, education, historical buildings…)
8. Specific problems in soft rocks.

CORRESPONDENCE

In a case of any technical or organizational matters regarding the Symposium, participants can obtain information from:

mag@gf.ukim.edu.mk
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phone no.: +389 2 3116 066 / ext.157 & 239
fax: +389 2 3 11 88 34
Faculty of Civil Engineering – Skopje, Blvd. Partizanski Odredi No. 24, 1000 Skopje

9th International Conference on Computational Methods for Coupled Problems in Science and Engineering (COUPLED PROBLEMS 2021), 13-16 June 2021, Sardinia, Italy, coupledproblems_sec@cimne.upc.edu

Rapid Excavation and Tunneling Conference RETC2021, June 13-16, 2021, Las Vegas, Nevada, USA, www.retc.org

Cities on Volcanoes 11 - Volcanoes and Society: environment, health and hazards, 14-18 June 2021, Heraklion, Crete, https://pcoconvin.eventsair.com/volcanoes11

Joint meeting of ISSMGE TC201 and TC210, ICOLD TC E and TC LE "Dams and Levees: Particle Movements – Case Studies, Experiments, Theory", June 16-19, 2021, Budapest, Hungary, www.isc6-budapest.com

6th International Conference on Geotechnical and Geophysical Site Characterization "Toward synergy at site characterisation", June 16-19, 2021, Budapest, Hungary, www.isc6-budapest.com

EGRWSE 2020 - 3rd International Conference on Environmental Geotechnology, Recycled Waste Materials and Sustainable Engineering, 17-19 June 2021, Izmir, Turkey, www.egrwse2020.com

2nd ICPE 2021 The Second International Conference on Pressin Engineering, 19-21 June 2021, Kochi, Japan, https://icpe-ipa.org/

DFNE 2021 3rd International Conference on Discrete Fracture Network Engineering (in conjunction with ARMA 2021), June 23-25, Houston, Texas, USA, www.dfne2021.org

1st International Conference on Sustainability in Geotechnical Engineering, ICSGE, 27-30 June 2021, Lisboa, Portugal, http://icsge.lnec.pt/#

ICONHIC2021: THE STEP FORWARD - 3rd International Conference on Natural Hazards & Infrastructure, 22 – 24 June 2021, Athens, GREECE, https://iconhic.com/2021

DFI Deep Mixing, 5-8 July 2020, TBD, Gdansk, Poland, www.dfi.org/DM2020

II International Seminar "Tailings and Waste Rock Disposal", July 12 – 14, 2021, Lima, Peru, www.geoingenieria.org.pe

7th ICRAGEE International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, 12-17 July 2021, Bengaluru, India, http://7icragee.org

AFRICA 2021 Water Storage and Hydropower Development for Africa, 13-15 July 2021, Lake Victoria, Uganda, www.hydropower-dams.com/africa-2021

GEOCHINA 2021 - 6th GeoChina International Conference Civil & Transportation Infrastructures: From Engineering to Smart & Green Life Cycle Solution, July 19 to 21, 2021, Nan-Chang, China, http://geochina2021.geoconf.org

PanAm Unsat 2021 3rd Pan-American Conference on Unsaturated Soils, 25-28 July 2021, Rio de Janeiro, Brazil, https://panamunsat2021.com

7th International Conference on Industrial and Hazardous Waste Management 27-30 July 2021, Chania, Crete, Greece, http://hwm-conferences.tuc.gr (online participation available)

ACE 2020 14th International Congress on Advances in Civil Engineering, September 2021, Istanbul, Turkey, www.ace2020.org/en

XVIth International Congress AFTES 2021 Underground, a space for innovation, 6 to 8 September 2021, www.aftes2020.com

COMPLAS 2021 XVI International Conference on Computational Plasticity, Fundamentals and Applications, 7-10 September 2021, Barcelona, Spain, https://congress.cimne.com/complas2021/frontal/default.asp

RMEGV 2021 - 5th International Workshop on Rock Mechanics and Engineering Geology in Volcanic Fields, 9÷11 September 2021, Fukuoka, Japan, https://ec-convention.com/rmegv2021

International Conference on Textile Composites and Inflatable Structures (MEMBRANES 2021), 13-15 September 2021, Munich, Germany, https://congress.cimne.com/membranes2021/frontal/default.asp

EUROGEO WARSAW 2020 7th European Geosynthetics Congress, 19-22 September 2021, Warsaw, Poland, www.eurogeo7.org

37th General Assembly of the European Seismological Commission, 19-24 September 2021, Corfu, Greece, www.escgreece2020.eu

EUROCK TORINO 2021 - ISRM European Rock Mechanics Symposium Rock Mechanics and Rock Engineering from theory to practice, 20-25 September 2021, Torino, Italy, http://eurock2021.com

This British Tunnelling Society "BTS 2020" Conference and Exhibition, Sept 30th - Oct 1st, 2021, London, United Kingdom, www.btsconference.com

Virtual EUROENGEO 3RD EUROPEAN REGIONAL CONFERENCE OF IAEG, 7 - 10 October 2021, Athens, Greece, www.euroengeo2020.org

10th International Conference on Scour and Erosion (ICSE-10), October 17-20, 2021, Arlington, Virginia, USA, www.engr.psu.edu/xiao/ICSE-10 Call for abstract.pdf

3rd International Symposium on Coupled Phenomena in Environmental Geotechnics, 20-22 October 2021, Kyoto, Japan, https://cpeg2020.org

ARMS11 11th Asian Rock Mechanics Symposium, Challenges and Opportunities in Rock Mechanics, 21-25 October 2021, Beijing, China, www.arms11.com

HYDRO 2021 Roles of hydro in the global recovery, 25-27 October 2021, Strasbourg, France, www.hydropower-dams.com/hydro-2021

EURO:TUN 2021 Computational Methods and Information Models in Tunneling, October 27th - 29th, 2021, Bochum, Germany, http://eurotun2021.rub.de

GFAC 2021 International Conference "Geotechnics fundamentals and applications in construction: investigations, design, technologies", October 27–29, 2021, Saint Petersburg, Russia https://gfac.spbgasu.ru

Emerging Technologies and Applications for Green Infrastructure, 28-29 October 2021, Ha Long, Vietnam, https://cigos2021.sciencesconf.org

5TH World Landslide Forum Implementation and Monitoring the USDR-ICL Sendai Partnerships 2015-2015, 2-6 November 2021, Kyoto, Japan, http://wlf5.iplhq.org

ISFOG 2020 4th International Symposium on Frontiers in Offshore Geotechnics, 8 – 11 November 2021, Austin, United States, www.isfog2020.org

2021 GEOASIA7 - 7th Asian Regional Conference on International Geosynthetics Society, November 22-26, 2021, Taipei, Taiwan, www.geoasia7.org

ICGE – Colombo – 2020 3rd International Conference in Geotechnical Engineering, 6-7 December 2021, Colombo, Sri Lanka, http://icgecolombo.org/2020/index.php

2nd International Conference TMM-CH Transdisciplinary Multispectral Modelling and Cooperation for the Preservation of Cultural Heritage - Rebranding The World In Crisis Through Culture, 12-15 December, 2021 Athens, Greece https://tmm-ch.com/

GeoAfrica 2021 - 4th African Regional Conference on Geosynthetics Geosynthetics in Sustainable Infrastructures and Mega Projects, 21-24 February 2022, Cairo, Egypt, https://geoafrica2021.org

ICEGT-2020 2nd International Conference on Energy Geotechnics, 10-13 April 2022, La Jolla, California, USA, https://icegt-2020.eng.ucsd.edu/home

WTC 2022 World Tunnel Congress 2022 - Underground solutions for a world in change, 22-28 April 2022, Copenhagen, Denmark, www.wtc2021.dk

SYDNEY 7iYGEC 2021 7th International Young Geotechnical Engineers Conference A Geotechnical Discovery Down Under, 29 April - 1 May 2022, Sydney, Australia, http://icsmge2021.org/7iygec

SYDNEY ICSMGE 2021 20th International Conference on Soil Mechanics and Geotechnical Engineering, 1–5 May 2022, Sydney, Australia, www.icsgme2021.org

LARMS 2021 – IX Latin American Rock Mechanics Symposium Challenges in rock mechanics: towards a sustainable development of infrastructure, 15 – 18 May 2022, Asuncion, Paraguay, https://larms2021.com

CPT'22

5th International Symposium on Cone Penetration Testing

8-10 June 2022, Bologna, Italy

The Italian Geotechnical Society (AGI) and the University of Bologna are pleased to announce the 5th International Symposium on Cone Penetration Testing, CPT'22, to be held in Bologna, Italy, on June 8-10, 2022. CPT'22, organized under the auspices of the ISSMGE Technical Committee TC102, follows the successful symposia held in Delft, The Netherlands (2018), Las Vegas, Nevada USA (2014), Huntington Beach, California USA (2010) and Linköping, Sweden (1995).

As tradition of the CPT events, which foster a lively debate on recent advancements on cone penetration testing, the Symposium aims at providing Researchers, Practitioners and Contractors with a unique opportunity of sharing up-to-date knowledge in equipment, testing procedures, data interpretation and related applications, as well as discussing emerging solutions and new ideas with the largest gathering of world's experts, academics and non-academics, working in the broad and dynamic area of CPTs.

Organizer

Italian Geotechnical Society (AGI) and University of Bologna (endorsed by TC102)

Contact Information

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Prof. Guido Gottardi (University of Bologna)

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Email: agi@associazionegeotecnica.it

3rd European Conference on Earthquake Engineering and Seismology (3ECEES), 19-24 June 2022, Bucharest, Romania, https://3ecees.ro

3rd International Symposium on Geotechnical Engineering for the Preservation of Monuments and Historic Sites

22-24 June 2022, Napoli, Italy

https://tc301-napoli.org

The conservation of monuments and historic sites is one of the most challenging problems facing modern civilization. It involves, in inextricable patterns, factors belonging to different fields (cultural, humanistic, social, technical, economical, administrative) and the requirements of safety and use appear (and often are) in conflict with the respect of the integrity of the monuments.

The complexity of the topic is such that a shared framework of reference is still lacking among art historians, architects, structural and geotechnical engineers.

This is proved by the fact that, although there are exemplary cases of an integral saving of any structural component with its static and architectural function, as a material witness of the culture and the construction techniques of the original historical period, there are still examples of uncritical confidence in modern technology which lead to the replacement of previous structures with new ones, which only preserve an iconic appearance of the original monument.

The possibility of finding in practice an acceptable equilibrium is linked to the development of a shared culture. For this reason, the International Society of Soil Mechanics and Geotechnical Engineering promoted over 30 years ago an ad hoc Committee (on Preservation of Monuments and Historic Sites), as suggested by Jean Kerisel and Arrigo Croce.

Since that founding period, a number of international and regional symposia have been organised, and in recognition of his pioneering work a honour lecture has been dedicated to Jean Kerisel. The first Kerisel Lecture was delivered at International Conference on Soil Mechanics and Geotechnical Engineering (ICSMGE) in 2013 in Paris; the second one at the ICSMGE in Seoul in 2017, and the third one will be offered during next International Conference of the TC301, which is now announced and will be held in Naples in June 2022, following the successful tradition started with the previous ones in 1996 and 2013.

Moving from **general principles and maintenance strategies of conservation**, the conference is addressed not only to geotechnical engineers but also to professionals from other disciplines to debate what is worth preserving and how is it possible. The contribution of **investigation and monitoring**, performed to reach a deep knowledge of the monument and its construction history, a prerequisite of any maintenance strategy, is a corollary theme of the conference.

In addition to basic requirements regarding the safeguarding and preservation of a single monument, a further very important task to be debated concerns the compatibility of demand of modern civilization with the preservation of historic sites and heritage. There is a need of expanding the reference terms, by considering **the effects of urban developments and tunneling on built heritage**, as well as considering the preservation of "diffuse heritage", i.e. problems related to the scale of a urban environment (slope stability, natural and man induced subsidence, underground infrastructures).

Dynamic identification analyses, effects of local soil condition and influence of soil-structure interaction are further demanding themes to be addressed in relation to **seismic risk and mitigation measures**.

Symposium topics

- Principles of conservation, maintenance strategies, case histories
- The knowledge: investigations and monitoring
- Seismic risk, site effects, soil structure interaction
- Effects of urban development and tunnelling on built heritage
- Preservation of diffuse heritage: soil instability, subsidence, environmental damages

Secretariat

For **general queries** please contact: info@tc301-napoli.org

For queries about **paper submission** please contact: secretary@tc301-napoli.org or Filomena de Silva (email: filomena.desilva@unina.it)

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9th International Congress on Environmental Geotechnics
Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges
26-29 June 2022, Chania, Crete island, Greece
www.iceg2022.org

The 9th International Congress on Environmental Geotechnics is part of the well established series of ICEG. This conference will be held on an outstanding resort in the town of Chania of the island of Crete in Greece. The theme of the conference is "Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges" and will highlight the leadership role of Geoenvironmental Engineers play on tackling our society's grand challenges.

Contact Information

- Contact person: Dr. Rallis Kourkoulis
- Email: rallisko@grid-engineers.com

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IS-Cambridge 2020 10th International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground, 27 - 29 June 2022, Cambridge, United Kingdom, www.is-cambridge2020.eng.cam.ac.uk

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UNSAT2022
8th International Conference on Unsaturated Soils
June or September 2022, Milos island, Greece

Eurock 2022

Rock and Fracture Mechanics in Rock Engineering and Mining
12÷15 September 2022, Helsinki, Finland
www.ril.fi/en/events/eurock-2022.html

Themes

- Rock mass Characterization
- Geophysics in rock mechanics
- Mechanics of rock joints
- Jointed rock mass behaviour
- Rock support, probability based design
- Rock stress measurements
- Constitutive modelling of rock
- Rock drilling
- Blast induced fractures
- Rock engineering and mining education
- Geological disposal of spent nuclear fuel
- Recent advances in rock mechanics research
- Field and laboratory investigations
- Case studies

Contact Person: Lauri Uotinen
E-mail: lauri.uotinen@aalto.fi

6th Australasian Ground Control in Mining Conference – AusRock 2022
17 – 19 September 2022, Melbourne, Australia

Organizer: UNSW Sydney, AusIMM
Contact Person: Ismet Cambulat
E-mail: icambulat@unsw.edu.au

XII ICG - 12th International Conference on Geosynthetics, September 18 – 22, 2022, Rome, Italy, www.12icg-roma.org

28th European Young Geotechnical Engineers Conference and Geogames, 17 – 19 September 2022, Moscow, Russia, https://www.eygec28.com/?

11th International Conference on Stress Wave Theory and Design and Testing Methods for Deep Foundations, 20 - 23 September 2022, De Doelen, Rotterdam, The Netherlands, https://www.kivi.nl/afdelingen/geotechniek/stress-wave-conference-2022

LARMS 2022

IX Latin American Congress on Rock Mechanics, Rock Testing and Site Characterization
an ISRM International Symposium
16-19 October 2022, Asuncion, Paraguay

Symposium Themes

- Site characterization,
- Rock mass properties,
- Rock mass classification,
- Foundations,
- Slopes,
- Tunnels,
- Soft Rock,
- Shotcrete

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AusRock 2022

6th Australasian Ground Control in Mining Conference –an ISRM Regional Symposium
07 -09 November 2022, Melbourne, Australia

Organizer: UNSW Sydney, AusIMM
Contact Person: Ismet Cambulat
E-mail: icambulat@unsw.edu.au

88th ICOLD Annual Meeting & Symposium on Sustainable Development of Dams and River Basins, April 2023, New Delhi, India, https://www.icold2020.org

15th ISRM

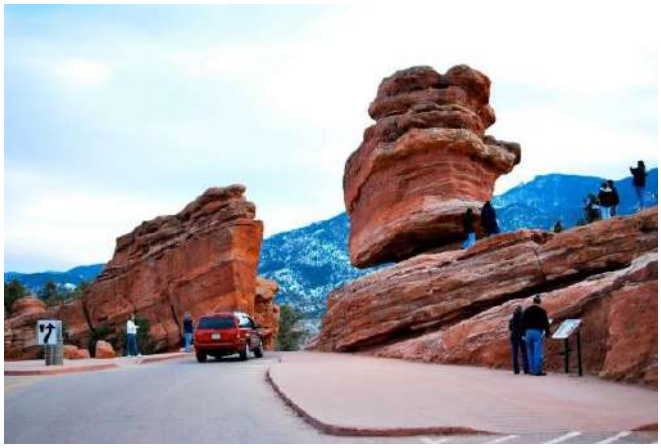
International Congress in Rock Mechanics
9÷14 October 2023, Salzburg, Austria

Organizer: Austrian Society for Geomechanics
Contact Person: Prof. Wulf Schubert
E-mail: salzburg@oegg.at

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Why Scientists Fall for Precariously Balanced Rocks

"They're nature's hilarious accidents."



Despite appearances, it is safe to drive by Balanced Rock in Colorado Springs.

On April 1, 1994, Paul Butcher, then the director of Colorado Springs parks department, received a chilling phone call from a frantic staff member. She told him that Balanced Rock—a 290-million-year-old red sandstone boulder naturally perched on a sloped ledge in Garden of the Gods Park—had fallen. Butcher panicked, his thoughts roiling with how disappointed and outraged both locals and visitors would be with the loss of the beloved, iconic landmark. He imagined the 700-ton boulder rolling downhill, with nothing to stop its tumble onto the nearby U.S. Highway 24, like a monstrously dense tumbleweed. Then he remembered the calendar, and realized it was a prank. "I never laughed," Butcher, who is now retired, told *Out There Colorado*. "It's not a great joke."

In a way, the mere existence of Balanced Rock also seems like a prank, either geological or cosmic. The enormous boulder looks like it had been photoshopped onto the landscape, or photographed mid-roll, or carefully placed by aliens. But it's no hoax and there's no sorcery to it. Rather it is a prime example of a whole category of geologic formations called "precariously balanced rocks"—PBRs, for short. They're exactly what you might expect. "It's a rock balanced on top of another rock," says Mark Stirling, who studies PBRs at the University of Otago in New Zealand. And if you think Colorado Springs' landmark ought to have a more imaginative name, see also: Balanced Rock in Grand Junction, Balanced Rock in Rocky Mountain National Park, and Balanced Rock at the Rampart Range. And that's just Colorado.

PBRs are more than just unusual geologic features—they're a source of valuable scientific insight. They're what are called "reverse seismometers" because their mere existence makes it possible to measure earthquakes that didn't happen. If they're still balanced, then the earth hasn't moved enough to knock them over, at least in the last few thousand years, according to geologists David E. Haddad and J. Ramón Arrowsmith in their seminal 2011 report *Geologic and Geomorphic Characterization of Precariously Balanced Rocks*. So scientists study them to understand a region's seismic history and, subsequently, predict what might come in the future.

"They're nature's hilarious accidents," says Amir Allam, a geologist at the University of Utah.

Balanced Rock, actually a hoodoo, in Chiricahua National Monument, Arizona.

PBRs are a subset of a larger category called "fragile geologic features," Stirling says. This includes any kind of rock that doesn't meet the precise standard of a detached boulder balancing on another boulder, such as hoodoos (a mushrooming rock attached to a tall spire pedestal) and glacial erratics (boulders transported by ancient glaciers to new resting places), which are also considered PBRs when they land on another, curved rock—or a few of them, like in the case of Balanced Rock in New York's Hudson Valley. Fragile geologic features also include other landforms, such as the Punta Ventana arch in Puerto Rico that recently collapsed as a result of a series of earthquakes. Though they don't fit neatly into PBR researchers' equations, they can be used in the same way to assess past and future earthquakes, Stirling says.

PBRs often start their journeys deep underground. Large chunks of rock develop spidery fractures, expanded by percolating water, until they become multiple smaller chunks, Allam says. As erosion lowers the ground level, over many thousands of years, the rocks come to the surface, often stacked atop each other. "You need the right kind of climate conditions to create PBRs, and you need the right climate to make them last," he says. "The American West is the perfect storm for this."

Bubble Rock, a PBR in Acadia National Park, Maine.

The whole PBR-science idea started in the 1990s with James Brune, a geologist at the California Institute of Technology. "Brune was an old school genius," Allam says. "He wore suspenders to all his presentations and wrote all his notes by

hand." Brune was assessing earthquake risk in Yucca Mountain, Nevada, to evaluate its future as a possible nuclear-waste storage site, when he noticed a handful of boulders balanced—rather precariously—on other stones, according to *American Scientist*. The boulders were all coated with desert varnish—a dark sheathe of clay, manganese, and iron oxides—indicating they had been exposed for millions of years. Brune realized the rocks offered a kind of record of the area's seismic history, or lack thereof. So, by running PBRs through computer models that replicate earthquakes, Brune figured he could determine what level and type of shaking it would take to topple a particular rock, and then therefore rule that shaking out of its recent history.

When Brune first introduced this idea, it ruffled more than a few feathers. "Twenty-five years ago, the whole topic of PBRs was a fringe area of seismology," Stirling says. "We were too edgy, too out of the mainstream." Back then, he says, seismologists studied earthquakes, paleoseismologists studied prehistoric earthquakes, and engineering seismologists studied ground motion. Brune's approach to PBRs straddled all these fields, and that kind of triple-dipping in science often leads to skepticism, Stirling says. Other early PBR enthusiasts also struggled to get funding and resources for their work. But a good idea is a good idea and they persisted, Stirling says, with Brune leading the charge. By the early 2010s, PBR science had respect within the field and funding from sources such as PG&E and other energy companies, who wanted to understand the earthquake risk for their plants.

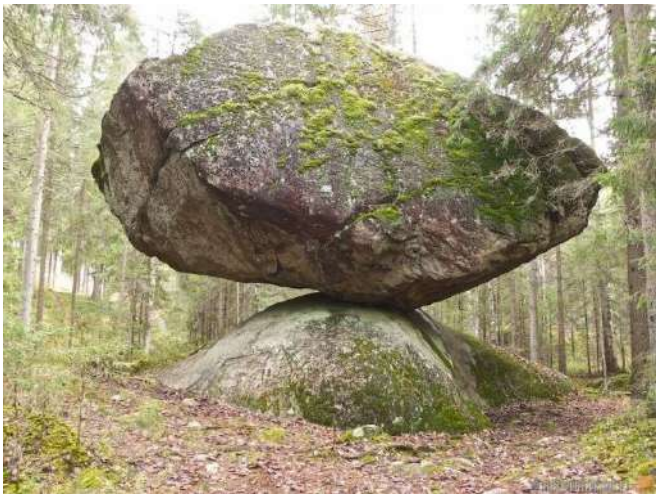
Allam studies Utah's seismic history, and colleagues even call him "the PBR guy." His chaotic website includes a tab for them—"PBR!"—and a quote from Japanese writer Haruki Murakami that carries extra meaning for seismologists: "My biggest fault is that the faults I was born with grow bigger each year." Allam is particularly enamored with shaking boulders enough to knock them over—only not in real life. "It's also because they're really cool," he admits.

Despite its name, Balanced Rock in Arches National Park, Utah is attached, not balanced. But it's still precarious!

Allam has made it his mission to map every PBR—and the forces required to topple them—in Utah. He's compiled at least 40 so far, but the trickiest thing about studying PBRs remains finding them in the first place. Allam has a whole team of undergrads who are, rather understandably, also pretty into PBRs. "I tell them to go on Google Earth, look for rocky outcrops, and then go drive out and check it out," he says. He also goes hiking with his students, to show them PBRs he's already identified and rely on their fresh eyes to spot more.

Once he finds a new PBR, Allam covers it with strips of tape to prepare it for photogrammetry, in which he merges photographs of the rock to construct a 3-D digital counterpart. To assess how long the rock has been precarious, Allam measures the concentrations of cosmogenic radionuclides on the underside of the rock, which offer a history of how long a rock has been exposed. The PBRs he studies tend to be approximately 30,000 years old. "Big earthquakes happen every 150 to 1,000 years, so 30,000 years is a statistically reliable data point," he says.

Once Allam has the model, he shakes it in a computerized earthquake simulation. He starts off small, with a peak horizontal ground acceleration of 0.2 g (that is, g-forces, or the acceleration due to gravity). If that doesn't do it, he goes to 0.25 g, and then maybe a little bit more until it comes tumbling down. No one wants to be in the way of a real falling rock, but he's not after a rock's threat level. "PBRs rarely fall and hurt people," Allam says, because most are so remote. "The earthquake itself is much more dangerous."



Kummakivi (Finnish for "strange rock") was deposited by a glacier.

The geology of Utah makes it a great place for PBRs, but they can be found throughout the world. In Lacrouzette, France, an oak and chestnut forest cloaks a large rock that bears a famously uncanny resemblance to a goose. Mount Desert, Maine, has Bubble Rock; Mahabalipuram, India, has Krishna's Butter Ball; and Ruokolahti, Finland, has Kummakivi. In Myanmar's Thaton District, Kyaiktiyo, a 25-foot-tall boulder perched on the edge of a cliff wears a small pagoda like a hat. (Rocky towers along the Hudson River between New Jersey and New York are actually manmade, by artist Uliks Gryka.)

Allam's shaking has to take place inside a lab because there is one cardinal rule of researching—or even just visiting—PBRs: Do not knock them over. All PBRs will eventually fall down, their bases worn down by erosion, their weight distribution changed by time, and the occasional earthquake, large or small. The chance of this happening to any particular PBR in a human lifetime is almost zilch, Allam says, but there is one other way that PBRs can come down.

Take 2012, when a scandal rocked the Utah Boy Scouts. Glenn Taylor, a scout leader, was filmed pushing over a hoodoo (what locals call a goblin) in Goblin Valley State Park, by a friend, David Hall. In the video, Taylor wedged himself against the boulder and heaved his weight into it. Nothing happened at first, but then the rock thudded to the ground, and Taylor high-fived his large adult son.

"It was an appalling act of vandalism," Stirling says. Taylor and Hall were sentenced to a year of probation, after pleading guilty to criminal mischief, according to the *Salt Lake Tribune*.

This specter does loom over some PBRs. All it takes is a moment. "Some of the huge ones could be easily dislodged with a couple of guys and a crowbar," Allam says. "Something the

size of a watermelon, well, you could push over yourself." Once, during one of his PBR surveys, Allam spoke with a shepherding family who say knocking over precarious rocks is a family tradition that runs back generations. "They said, 'Our favorite thing is to roll boulders down a mountain," he says. "Which makes sense, if you're bored and surrounded by nothing but sheep."

A row of hoodoos at Goblin Valley State Park, Utah. (Please leave them alone.)

Felled PBRs—dropped by causes natural or unnatural, can be almost indistinguishable from ordinary boulders, unless you know what you're looking for. If you see some smaller boulders scattered around an area with still-balanced PBRs, there's a good chance you're looking at their former neighbors, perhaps grounded by human hands. In the future, Stirling says, he hopes that fragile rock formations will be treated with the same reverence as archaeological sites.

"Once it's toppled," Allam says, "there's no getting back to the past."

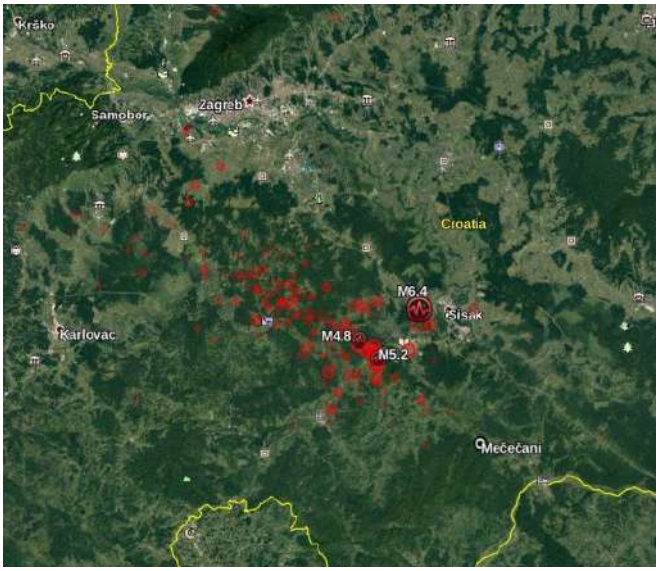
(Sabrina Imbler / Atlas Obscura, January 9, 2020, https://www.atlasobscura.com/articles/precariously-balanced-rocks)

Large sinkholes still opening one month after destructive M6.4 earthquake in Petrinja, Croatia

One month after the most powerful earthquake in the history of Croatia -- M6.4 in Petrinja on December 29, 2020 -- large sinkholes are still opening near the epicenter.

Numerous sinkholes have opened up in the village of Mečenčani, located about 25 km (15 miles) from the epicenter, after the earthquake struck on December 29.

Thousands of aftershocks were registered after the quake, with new ones still being detected every day.



Earthquakes detected by the EMSC in Croatia from December 27, 2020, to January 28, 2021.

Some of the holes are several meters wide, with the largest up to 30 m (100 feet) and more. The largest hole is about 15 m (50 feet) deep, but most of the holes are filled with water, making depth estimates difficult.

The existing holes are still growing, displacing residents, and new ones are still opening in the area every day.

Some of the growing holes are so close to homes, there are fears some of them might get swallowed in.

According to locals, holes started appearing 2 days before the mainshock, but their number rapidly increased on December 29.

10 days after the quake there were 15 holes in the village, with at least another 15 nearby.

Experts said sinkholes in this karst region would open up eventually even without the quake.

https://www.youtube.com/watch?v=DIirNzy_TUg&feature=emb_logo

The quake directly affected 116 000 people. The worst affected are the cities of Petrinja, Sisak, and Glina, and rural areas around them.

More than 35 000 homes, 4 550 businesses, including family farms, were damaged -- with many destroyed.

https://www.youtube.com/watch?v=wakluREpIcQ&feature=emb_logo

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https://www.youtube.com/watch?v=svfKouI0b7k&feature=emb_logo

(Teo Blašković / THE WATCHERS, January 28, 2021, https://watchers.news/2021/01/28/sinkholes-croatia-after-m6-4-earthquake-petrinja)

https://www.youtube.com/watch?v=Qeo6UqI2HAI&feature=emb_logo

56 schools were damaged, of which 9 collapsed, and 30 churches, of which 10 collapsed.

7 deaths were reported -- 5 in Majske Poljane, 2 in Žažinja and 1 in Petrinja.

Landslide swept away section of Highway 1 in California

Landslide swept away part of Highway 1 in California.

A 45-meter section of California's Highway 1 has been swept away by a large landslide.

Highway 1 is the longest route in California stretching for more than 1,000 km and running along the western coast of the United States. However, it is situated on relatively steep slopes that are prone to coastal erosion and have historically caused landslides and subsequently, structural damage. According to certain reports, the Highway has not been continuously operational for more than a year since its opening in 1937. "This road is prone to rockfalls and slides, and this is just the nature of the highway. We built a road on the edge of a continent, and we have the forces of the hillside and the ocean always at play," Kevin Drabinski, a spokesman for the California Department of Transportation, stated.

The ground failure struck Highway 1 near Rat Creek (around 32 km away from Big Sur) on Friday, January 29, 2021. A large section of the road and massive amounts of debris ended up into the Pacific Ocean. *Drone Footage from the failure can be found in the Media Section below.*

Based on the existing sources, it is deduced that intense rainfalls triggered a debris flow above the roadway which destroyed the drainage infrastructure and caused soil saturation and pore-water pressure to build up beneath the road. The increase of pore-water pressure in saturated soil results in a significant loss of shear strength and can be a triggering factor for landslides. It is highly probable that additional materials (e.g. debris, trees, boulders, etc.) that were deposited at the roadway the previous day, increased the stresses applied to the soil beneath and contributing to the landslide. Fortunately, authorities had closed the highway on time and no casualties were reported.

Scientists believe that the ground failure is associated with the wildfires that have devastated California in the past years. The absence of vegetation makes the absorption of rainwater impossible and results in extensive floods and in debris flows like the one that triggered the current failure. The area of the collapse lies near a region that was impacted by the Dolan fire (August 2020) and received more than 400mm of precipitation.

The section of the roadway will remain closed for a significant amount of time while the total cost of repair works has not been determined yet. Travelers can use a parallel highway (U.S. 101) to avoid the damaged section but the distance and time of travel are significantly increased.

The roadway failure has attracted the attention of interest but, there are 60 more locations along the highway that were also damaged or impacted by falling debris. Extensive repair works are being implemented to restore the affected sections.

In 2017, a massive landslide struck Highway 1 at Mud Creek, Big Sur coast. The landslide impacted a road section of 250 meters. It measured more than 10 meters in depth and carried away more than 1 million tons of debris.

(Geoengineer.org, Feb, 08, 2021, https://www.geoengineer.org/news/landslide-swept-away-part-of-highway-1-in-california)

The World's Coolest Underground Attractions

Venture beneath the surface and discover a whole new world of wonder

Jacques Cousteau famously said, "From birth, man carries the weight of gravity on his shoulders. He is bolted to earth. But man has only to sink beneath the surface and he is free." In our travels, it is beneath the surface where we can discover the most fascinating adventures. From underground burial chambers to subterranean amusement parks, we've rounded up the coolest attractions you can find underground.

Paris Catacombs, France

The remains of over six million bodies lie in the labyrinth of the Paris Catacombs 20 meters beneath the city's streets. The city's overrun cemeteries in the eighteenth century led the government to begin moving the dead to underground locations, inadvertently creating a spooky spot that has been attracting tourists for generations.

Wielicza Salt Mine, Poland

This designated UNESCO World Heritage site was known as one of the oldest salt mines in operation until it ceased production in 2007. Hand carved caves and brine lakes mark the fascinating trip 500 feet beneath the medieval town of Wielicza. Just a half-day trip from Krakow, tours of the mine dive deeper into its history, where you can marvel at the ornate chapel of the Blessed Kinga, where its intricate details are made from salt deposits.

Salina Turda, Romania

A 4.5 hour trip from Bucharest, the Salina Turda--known as the largest salt mine in the world--has been transformed into a subterranean amusement park 368 feet (120 meters) underground. The depths for entertainment and relaxation are limitless: an underground lake for boating, a halotherapy spa, and even a bowling alley.

Churchill War Rooms, England

Rated as one of the top things to do in London, England, The Churchill War Rooms is a fascinating look into the bunker that sheltered then-Prime Minister Winston Churchill and his war cabinet from German bomb raids and was used as the head-quarters to strategize the allied route to victory during the Second World War. Don't miss the Map Room, which has re-mained in the same condition as it was in 1945.

Underground City, Montreal

The 20 mile (32 kilometer) network of shops, restaurants, and other entertainment attractions lies underneath the streets of downtown Montreal. It is a refuge in the city's freezing winter months and ideal for a souvenir pick-up or something for yourself. It's more than just a mall, and the longer you spend perusing, the more you'll forget that there's actually no sun or sky in sight.

Cenote Ik Kil, Mexico

The iconic sinkhole of Cenote Ik Kil is a unique way to "dive deep" into Mexico's subterranean culture. Descend into a limestone carved stairway, accented with hanging vines to the swimming platform, where you can jump into a pool that is 40 meters deep. Cenote Ik Kil is a popular pit-stop en route to Chichen Itza and in this small-group day trip, you'll also visit the ancient Mayan city of Coba.

Crystal & Fantasy Caves, Bermuda

Founded by two teenagers while running after a ball during a cricket match, the Crystal & Fantasy Cave is one Bermuda's most stunning natural wonders. The dripping stalactites and shimmering Cahow Lake when lit make for a fun photo op-portunity.

Dambulla Cave Temple, Sri Lanka

The Dambulla Cave Temple--also known as The Golden Tem-

ple of Dambulla--is the largest and best preserved cave-temple complex in Sri Lanka. Five caves house the highlights of this UNESCO World Heritage Site, including a 100-foot-tall Buddha gilded in gold at its entrance; mural paintings encompassing the cave walls, and more than 150 statues honoring Buddha, gods, goddesses, and royalty.

Waitomo Glowworm Caves, New Zealand

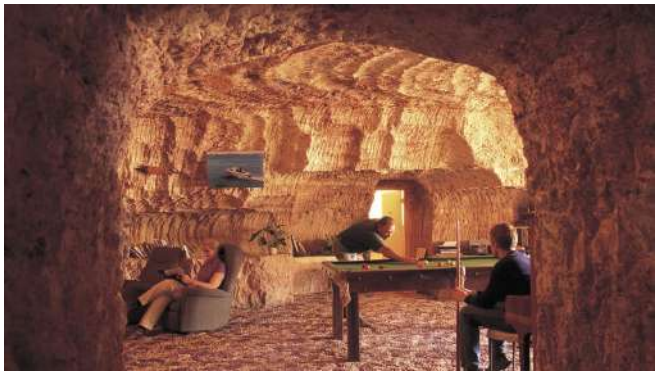
These famous caves are about a 2.5-hour drive from Auckland. Waitomo is a Maori word, which can be translated as the 'stream which flows into the hold in the ground' and it is exactly what you'll experience in this underground cave illuminated by its high population of glowworms.

Moscow Metro Station, Russia

As one of the busiest transit systems in the world, Moscow's metro serves up to 9 million passengers a day. In the Cold War era, stations like the Mayakovskaya Metro Station were built as shelters in the case of a nuclear war beneath its glamorous Baroque architecture.

(Viator, Feb 10, 2021, https://www.viator.com/blog/article/The-Worlds-Coolest-Underground-Attractions/l93592?mcid=56757)

Satc Milton Wordley



Most residents of this South Australian town live underground, to escape the blazing outback heat. There are subterranean shops, a hotel and a restaurant.

Wieliczka salt mine

A chapel and cathedral carved out by miners are highlights here, under chandeliers made from rock salt.

Cappadocia

Carving of Cappadocia's vast underground cities may have begun three millennia ago.

Tokyo's underground watr tanks

This engineering marvel was built to keep Tokyo dry during the rainy season.

Nottingham Castle

Nottingham's medieval housing estate has an unlikely entrance -- in a shopping center.

(Tamara Hinson / CNN, 18th November 2013, www.edition.cnn.com/travel/article/underground-attractions/index.html)

Hidden Underground: How One Kansas Town is Key in Preserving Movie Industry's History

USFR-AMC Salt Mine

Take a ride down an elevator 650 feet below the surface of Hutchinson, Kansas and you'll find endless miles of tunnels that lead to active salt mines dating back over a century.

"They mined out over 980 acres of salt in this mine," says Lee Spence, president and CEO of Underground Vaults and Storage, located Hutchinson, Kan. "On a daily basis, they produce right around 5000 tons of salt every day."

About 80 % of this salt is used to treat roads during the winter, the remainder is used for agricultural purposes. As the salt was mined, vast areas underground were now large empty spaces. Some of the company's owners were connected to the World War II Monuments Men group who worked to recover valuable items Hitler had seized and stored in salt mines in German controlled areas.

"The idea kind of surfaces from there that we could do the same thing and store valuable records and artifacts, store it right here in the middle of the state of Kansas," says Spence.

The company began in the late 1950s and has continued to grow here in the salt caverns below ground.

"Behind me is a private storage area called a bay and we have 106 of these bays that's 15,000 square feet, and we actually just build shelving and we set it up and we set it up to actually store - this one happens to be movie film," adds Spence.

And movie film alone accounts for 30% to 40% of their business.

"We get a lot of the major motion picture studios that store with us because of the preservation of the film that the salt provide and it's the security, as well," he says.

The temperature underground is a constant 68 degrees with humidity between 40% and 45%. And many directors and motion picture companies still like to shoot on film. There are rows and rows of boxes here – for the film industry alone with some works that date to the early days of movie making.

"We go back to the 1920s during the silent films, the black and white films, I've seen some films with Charlie Chaplin's name on them," says Spence.

Spence can't mention all the original films stored here, but he can certainly rattle off some titles that just about everyone would know.

"The classics like 'Wizard of Oz', we also have 'Gone with the Wind', 'Ben Hur', the 'Star Wars' collection is all here, as well," he says.

Interestingly, movie companies often retrieve those old films to use in new movie scenes or other projects. You can't tour the storage side of the business, but you can take salt mine tours which show how they use the mines for securing film and things like medical records, employer files and much more. And the business continues to grow because it seems all of us could always use a little extra space to store something…

"Yeah we're always pack rats and people are always leery of throwing something away because you always might need something," says Spence.

There are row and rows of storage shelves here, everything from classic movies to tv shows plus medical records and much more, just part of the vast storage network in this salt mine 650 feet below ground.

(U.S. Farm Report, February 15, 2021, https://www.agweb.com/news/business/technology/hidden-underground-how-one-kansas-town-key-preserving-movie-industrys)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

New Report Charts Path Toward Superior Earthquake Recovery

In 2011, a magnitude 6.3 earthquake struck Christchurch, New Zealand, damaging the city's central business district so severely that hundreds of buildings were closed or demolished.

For the last century, seismic building codes and practices have primarily focused on saving lives by reducing the likelihood of significant damage or structural collapse. Recovery of critical functions provided by buildings and infrastructure have received less attention, however. As a result, many remain vulnerable to being knocked out of service by an earthquake for months, years or for good.

A committee of experts, formed by the National Institute of Standards and Technology (NIST) and the Federal Emergency Management Agency (FEMA) under the direction of Congress, has urged officials at all levels of government to support research and policies that could help get the buildings and services society depends on up and running quickly after an earthquake. In a report delivered to Congress, the committee outlines seven recommendations that, if acted upon, may greatly improve the resilience of communities across the nation.

"As structural engineers we feel confident that the current building codes can deliver life safety design objectives. Now, it's time to go beyond that and think about recovery of function," said Siamak Sattar, a NIST structural engineer and co-author of the report.

In 2011, a magnitude 6.3 earthquake struck Christchurch, New Zealand. Over 180 lives were lost as a result, but many more were likely saved by modern building codes. However, the city's economy and quality of life were not spared.

The quake damaged the city's central business district to the point that hundreds of buildings were closed or demolished, displacing thousands of workers. Lifeline infrastructure systems — including power, clean water and roads — sustained heavy damage, further crippling the community's ability to bounce back. In total, the estimated costs of rebuilding the city amounted to 40 billion New Zealand dollars ($26.6 billion).

The toll taken by the Christchurch earthquake and other damaging events can in part be attributed to limitations in seismic codes and standards, as most offer little guidance on designing buildings or lifelines to recover in a timely manner in the wake of extreme events.

To prevent major earthquakes from leaving such lasting impressions in the future, Congress entrusted NIST and FEMA — both member agencies of the National Earthquake Hazards Reduction Program (NEHRP), which NIST leads — with the responsibility of mapping a path to greater community resilience.

Drawing expertise from both public and private sectors, NIST and FEMA assembled a committee of more than 30 engineers, architects, building owners, code officials and social scientists, including several of their own researchers, to devise options for addressing gaps in codes, standards and practices, which are described in their report to Congress.

The first recommendation summarizes the core of the report. The authors call for members of the government, codes and standards organizations, and industry to work together in developing a national framework for setting and achieving goals based on recovery time. To produce this framework, experts must first identify what level of function provided by buildings and lifelines should be maintained after an earth-quake, and then determine an acceptable time for them to be out of commission.

"There are different metrics that we can use to help guide this framework. For example, a building may need to recover within a predefined number of days, weeks or months. If it is a hospital or emergency center then you may not want it to go down at all," said Steve McCabe, director of NEHRP.

The authors also highlight the need for new recovery-based design criteria for buildings and lifelines. If developed with recovery in mind, these criteria could steer design parameters — such as increasing a school's structural strength to limit damage or designing an electrical power supply to return to service faster — toward improving community resilience. A critical phase of this process would be identifying the level of ground shaking that designs should be tailored to for recovery goals, which may vary by region.

Other recommendations seek to help leaders meet recovery goals aligned with the first recommendation, offering guidance on implementing new design requirements for buildings and lifelines. They also provide direction for pre-disaster planning — a key step in preparing authorities to make timely decisions in the immediate aftermath of a disaster.

The authors seek to empower communities as well by recommending the launch of an education campaign on earthquake risk and recovery, which could reach the public through social media, streaming services or other media.

"Informed citizens are an important resource needed to develop the kind of vision required for this effort, which may well represent the largest change in building codes in 75 years," McCabe said.

In the report, the authors encourage officials to consider adopting functional recovery approaches that go beyond the current requirements. They assert that the initial investments of adopting new recovery-focused codes and upgrading older buildings and lifelines could likely be offset by the reduction of future losses. They also suggest that increased access to financial resources through mechanisms such as grant programs, incentive systems and public financing would help local governments scale the upfront costs.

"The immediate aim of the report is to spark a national conversation about developing a consensus for recovery goals

and timelines. This approach may eventually be reflected in building codes, but first, a considerable amount of research must be tackled," Sattar said.

New policies could make use of the NEHRP agencies, such as NIST and FEMA, whose expertise may enable them to provide the necessary science for sound public policy.

The road toward this goal could take years to traverse, but it is critical.

In the meantime, the authors encourage early action by leaders at state and local levels, as each community may have needs that national guidelines cannot fully address. Their experiences with functional recovery planning and design could also make for valuable feedback at the national level, speeding up progress toward widespread earthquake resilience that preserves quality of life in addition to life itself.

The full report to Congress is now available online.

(January 27, 2021, National Institute of Standards and Technology / U.S. Department of Commerce, https://www.nist.gov/news-events/news/2021/01/new-report-charts-path-toward-superior-earthquake-recovery)

Tsunamis and tsunami warning: Recent progress and future prospects

Tsunamis are one of the most destructive disasters in the ocean. Large tsunamis are mostly generated by earthquakes, and they can propagate across the ocean without significantly losing energy. During the shoaling process in coastal areas, the wave amplitude increases dramatically, causing severe life loss and property damage. There have been frequent tsunamis since the 21st century, drawing the attention of many countries on the study of tsunami mechanisms and warning. Tsunami records also play an essential role in deriving earthquake rupture models in subduction zones.

A recent paper entitled "Tsunamis and tsunami warning: recent progress and future prospects," by Dr. Chao An from Shanghai Jiao Tong University reviews the recent research progress on earthquake-generated tsunamis, from the aspects of tsunami generation, propagation, inversion and warning. The paper was published in *Science China Earth Sciences* recently.

On tsunami generation, the paper analyzes three assumptions adopted in tsunami modeling and the associated errors, i.e., neglecting earthquake rupture process, assuming sea surface profile mimics seafloor deformation, and ignoring water compressibility. On tsunami propagation, popular simulation techniques are based on shallow water wave equations or Bousinessq equations of weak nonlinearity and weak dispersion; the paper reviews research results on the effects of Earth elasticity, water compressibility and ocean stratification. On tsunami inversion, the paper summarizes popular inversion methods including finite-fault inversion, initial sea surface profile inversion and time reversal method.

Tsunami warning strategies according to source distance and available observations Credit: ©Science China Press

The paper points out that tsunami data are of essential importance to constrain earthquake rupture parameters, but it has limited spatial and temporal resolution. On tsunami warning, the paper concludes that tsunami buoys are the most reliable way for tsunami warning. Without tsunami buoys, it is potentially possible to obtain accurate tsunami predictions by estimating the overall earthquake rupture characteristics and constructing uniform slip models. Lastly, the paper briefly introduces the newly-developed method, i.e., Probabilistic Tsunami Hazard Assessment (PTHA), and points out that a possible improvement is to take regional geological structures into consideration.

By reviewing the most recent tsunami research, the following conclusions are obtained:

1. Since the 2004 Sumatra tsunami, there have been more and more tsunami measurements. As a result, a lot of research has been done and the research methodologies have been well developed. With the deployment of ocean-bottom pressure sensors, it is possible to investigate multiple physical phenomena in an earthquake-tsunami event.

2. By far tsunami buoys are still the most reliable ways of tsunami warning. If tsunami measurements are not available, one possible warning strategy is to estimate the overall characteristics of earthquakes use simplified uniform models to predict tsunami waves.

3. Probabilistic methods are developed for tsunami hazard assessment in addition to traditional deterministic methods. A possible improvement is to take regional geological structures into consideration.

(Science China Press, February 2, 2021, https://phys.org/news/2021-02-tsunamis-tsunami-future-prospects.html)

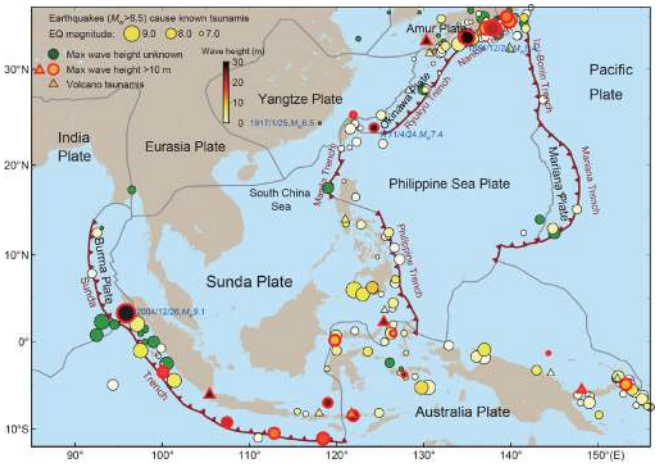
Tsunamis and tsunami warning: Recent progress and future prospects

Chao AN

Abstract

Tsunamis are one of the most destructive disasters in the ocean. Large tsunamis are mostly generated by earthquakes, and they can propagate across the ocean without significantly losing energy. During the shoaling process in coastal areas, the wave amplitude increases dramatically, causing severe life loss and property damage. There have been frequent tsunamis since the 21st century, drawing the attention of many countries on the study of tsunami mechanism and warning. Tsunami records also play an essential role in deriving earthquake rupture models in subduction zones. This paper reviews the recent progress and limitations of tsunami research, from the aspects of tsunami generation, propagation, inversion and warning. Potential tsunami warning strategies

are discussed and future prospects on tsunami research are provided.

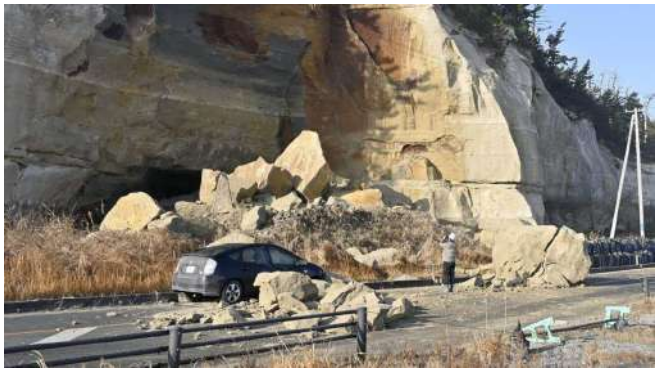


Historical tsunamis in Asia-Pacific marginal seas. Circles denote earthquake-triggered tsunamis, and the size indicates the earthquake magnitude. Triangles represent volcano-generated tsunamis. Filled colors show the known water height. Symbols with a red outer line indicates a water height greater than 10 m. Data source: NOAA's tsunami data base (https://www.ngdc.noaa.gov/hazard/tsu_db.shtml).

SCIENCE CHINA Earth Sciences, Volume 64 , Issue 2 : 191-204(2021) https://doi.org/10.1007/s11430-020-9672-7

(https://engine.scichina.com/publisher/scp/journal/SCES/64/2/10.1007/s11430-020-9672-7?slug=figAndTable)

The Fukushima quake may be an echo of the 2011 disaster—and a warning for the future



A 7.1 magnitude earthquake was recorded off the coast of Fukushima Prefecture in northeastern Japan on Saturday night, injuring around 100 people, closing roads and trains, and leaving almost a million people without electricity overnight.

It came almost 10 years after the nearby Tohoku quake of March 2011, a magnitude 9.0 earthquake that caused a catastrophic tsunami and resulted in thousands of deaths and a nuclear reactor meltdown.

In the hours after Saturday's quake, there were several aftershocks up to magnitude 5, and officials warned there could be more to come.

The Japan Meteorological Agency said the quake itself was an aftershock of the 2011 event. That might seem odd, but aftershocks of a major earthquake can persist for years and even decades.

How do you know if it's an aftershock?

The earthquake occurred in what's a called a "subduction zone", where the Pacific tectonic plate slides under the plate on which northern Japan sits at a rate of 7 to 10 cm per year. It's an area where there are a lot of earthquakes. It was a structurally simple earthquake: what's called a "thrust" or "reverse slip" quake, in which rock above the fault moves up and over the rock below the fault.

In areas with low seismic activity, we can recognise aftershock patterns for years and decades after a major quake. The Christchurch earthquake of 2016, for example, was an aftershock of the 2010 quake. Some scientists think aftershock sequences in regions like the eastern USA and Australia may persist for centuries.

In these seismically quiet places, it's relatively easier to spot aftershocks. The main hallmark is that the rate of quakes in an area is higher after a major quake than it was before. When the rate of quakes has dropped back to what it was originally, we say the aftershocks have stopped.

After the 2011 earthquake, a tsunami swept away houses and other buildings.

However, in places like Japan with high seismic activity, it can be hard to say whether one earthquake is an aftershock of another.

On one hand, the rates of aftershocks reduced to pre-2011 rates within about 3 years of the Tohoku earthquake and thus the sequence may have concluded.

On the other hand, rates of seismic activity were continuing to decrease in a fashion consistent with an ongoing aftershock sequence. And Saturday's earthquake appears to have occurred in an area that generated fewer immediate aftershocks following the 2011 event, suggesting this earthquake could have occurred as rupture of a remaining "sticky part" of the 2011 fault that generated the Tohoku earthquake.

So was this an aftershock?

It's certainly plausible that Saturday's quake was an aftershock.

The 2011 quake was enormous — the largest ever recorded in Japan, and the fourth-largest worldwide since modern rec-

ord-keeping began around 1900. It released around 1,000 times as much energy as Saturday's earthquake, and created a rupture more than 500 km long with 10s of meters of slip. But the slip on the fault was not uniform and seismic activity continued in some areas that did not fail entirely in that earthquake.

Given all this, it's almost certain there will be *some* relationship between the two quakes.

Epicentres of the 2021 and 2011 quakes

What's more, there have been relatively few aftershocks of the 2011 quake close to where this one happened. This suggests it might have been a "balancing out" of stresses.

On the other hand, there have been several magnitude 7 quakes over the past century within 100 kilometres or so of this one, so it's hardly out of the ordinary.

A definite answer on whether this was an aftershock or not will require detailed analysis of the quake and others in the region.

What we can learn from this

A quake like this one can be a valuable reminder of how important it is to learn the lessons of a disaster.

The earthquake generated very strong shaking in areas of Japan that were severely affected by the 2011 earthquake shaking and tsunami. Effects such as liquefaction are likely to have occurred again.

People sometimes think a big quake relieves stress built up in Earth's crust and you can relax afterwards. In reality, it's the opposite. When you have a big quake, there's a higher probability you'll have more to come. Subsequent earthquakes, whether they adhere to statistical definitions of aftershocks or not, can induce recurrent hazards that cause more damage to buildings and infrastructure and present risks to human life.

After a disaster, it is critical to act to reduce future exposure and vulnerability to future disasters through actions such as more considered land-use planning informed in part by better maps of seismic hazards, enhancing coastal protection through engineering of sea-walls and breakwaters and using vegetation, and making sure that warning and evacuation protocols are efficient and effective.

Japan is a world leader in many of these aspects, and the lessons learned from Tohoku are likely to have generated outcomes that minimised some of the loss and damage that could have otherwise occurred from Saturday's earthquake.

(The Conversation, February 15, 2021, https://theconversation.com/the-fukushima-quake-may-be-an-echo-of-the-2011-disaster-and-a-warning-for-the-future-155293)

Powerful Japan quake sets off landslide, minor injuries

Residents in northeastern Japan on Sunday cleaned up clutter and debris in stores and homes after a strong earthquake set off a landslide on a highway, damaged buildings and parts of bullet train lines and caused power blackouts for thousands of people.

The 7.3 magnitude temblor late Saturday shook the quake-prone areas of Fukushima and Miyagi prefectures that 10 years ago had been hit by a powerful earthquake that triggered a tsunami and a meltdown at a nuclear power plant.

More than 140 people suffered mostly minor injures, many of them by falling objects and cuts while stepping on broken glass. Three people were confirmed with serious injures but there were no reports of deaths, Chief Cabinet Secretary Katsunobu Kato said.

Tokyo Electric Power Co., the utility that runs the Fukushima Dai-ichi nuclear power plant that was hit by the March 2011 disaster, said the water used to cool spent fuel rods near the reactors had spilled because of the shaking. But there were no radiation leaks or other irregularities, TEPCO said.

The quake did not cause a tsunami because the epicenter was deep at 55 kilometers (34 miles) beneath the ocean.

Noriko Kamaya, a Japan Meteorological Agency spokesperson, said in a news conference that the quake is considered to be an aftershock of the 9.1 magnitude quake in 2011.

(Geology Science, February 15, 2021, https://geology-science.info/powerful-japan-quake-sets-off-landslide-minor-injuries)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΓΕΩΛΟΓΙΑ

Finding a missing tectonic plate

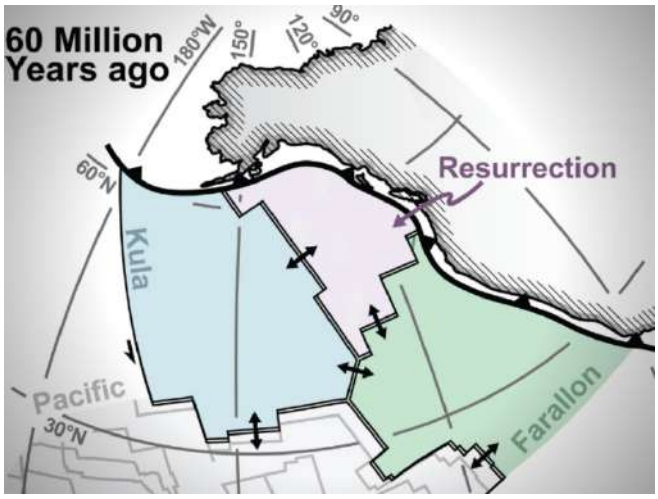


Plate tectonic reconstruction of western North America showing subduction of three key tectonic plates, Kula, Farallon and Resurrection. Credits: UH More

Scientists from the University of Houston have managed to detect signs of a controversial tectonic plate knows as the Resurrection Plate.

The existence of the Resurrection Plate is an issue long debated with many experts stating in the past that the plate never existed. However, according to the new study, published in October 2020, in the Journal Geological Society of America Bulletin, evidence that proves the existence of the plate was discovered.

Plate tectonics is an accepted theory suggesting that the outer part of Earth is divided into smaller rigid pieces that move against or break away from each over. Those pieces are known as tectonic plates and tend to slide over a less rigid formation known as the mantle of the earth. The mechanism that drives the movements of plates is heat transfer between the different layers of the planet and can be explained by the discipline of thermodynamics. The types of potential movements are complex consisting of mid-ocean ridges where two plates detach and magma flows forming new crust and subduction zones where two plates collide with one being pushed under the crust. Over millions of years, those complicated mechanisms re-arrange entirely the landscape of Earth and re-shape the plates themselves.

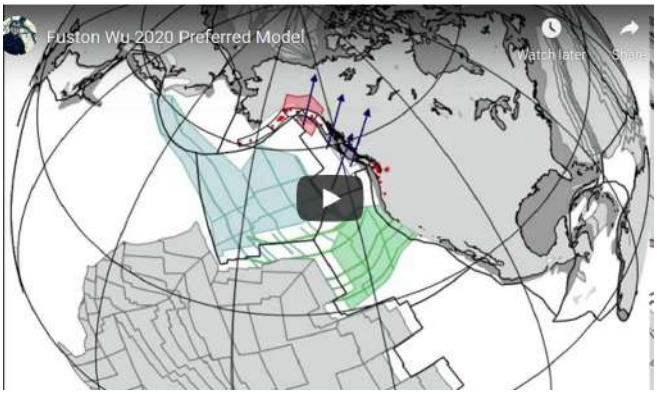
The debate over the existence of the Resurrection plate is long-lasting and involves a complex interpretation of North America's regime, In particular, two volcanic chains formed at about the same time period, one in Alaska and the other in the coastal line of Washington and Oregon. The question is why these zones are distanced about 4,000km and geologists suggest two prevailing scenarios: 1) The volcanic chains were once together and were gradually separated or 2) They were interconnected through a plate boundary that does not exist anymore.

The authors of the study utilized a method known as mantle tomography which enables the reconstruction of the subsurface using seismic waves. In particular, they applied a 3-dimensional technique developed at the University of Houston specified for slab unfolding. The 3-dimensional reconstruction revealed that the debated plate is currently under the Kula and the Farallon plates.

The Kula plate used to be an oceanic plate before it was subducted under the North American plate and the region that used to occupy is now captured by the Pacific Plate. The Farallon Plate was also an oceanic plate that subducted beneath the North American Plate during the Jurassic period. The Resurrection Plate was detected near the volcanic belts proving the existence of a former subduction zone. "We believe we have direct evidence that the Resurrection plate existed. We are also trying to solve a debate and advocate for which side our data support," S. Fuston, lead author of the study and a Ph.D. candidate at the University of Houston, stated.

The Resurrection Plate probably existed about 40 and 60 million years ago.

A video of the suggested model uploaded by S. Fuston can be found below.



Fuston Wu 2020 Preferred Model, https://www.youtube.com/watch?v=trIMtS098PQ&feature=emb_logo

(Geoengineer.org, Oct, 19, 2020, https://www.geoengineer.org/news/finding-a-missing-tectonic-plate)

Raising the Resurrection plate from an unfolded-slab plate tectonic reconstruction of northwestern North America since early Cenozoic time

Spencer Fuston, Jonny Wu

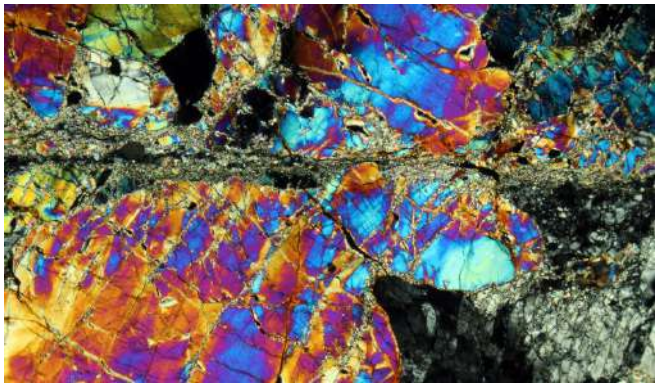
The configuration of mid-ocean ridges subducted below North America prior to Oligocene time is unconstrained by seafloor isochrons and has been primarily inferred from upper-plate geology, including near-trench magmatism. However, many tectonic models are permitted from these constraints. We present a fully kinematic, plate tectonic reconstruction of the NW Cordillera since 60 Ma built by structurally unfolding subducted slabs, imaged by mantle tomography, back to Earth's surface. We map in three-dimensions the attached Alaska and Cascadia slabs, and a detached slab below western Yukon (Canada) at 400–600 km depth that we call the "Yukon Slab." Our restoration of these lower plates within a global plate model indicates the Alaska slab accounts for Pacific-Kula subduction since ca. 60 Ma below the Aleutian Islands whereas the Cascadia slab accounts for Farallon subduction since at least ca. 75 Ma below southern California, USA. However, intermediate areas show two reconstruction gaps that persist until 40 Ma. We show that these reconstruction gaps correlate spatiotemporally to published NW Cordillera near-

trench magmatism, even considering possible terrane translation. We attribute these gaps to thermal erosion related to ridge subduction and model mid-ocean ridges within these reconstruction gap mid-points. Our reconstructions show two coeval ridge-trench intersections that bound an additional "Resurrection"-like plate along the NW Cordillera prior to 40 Ma. In this model, the Yukon slab represents a thermally eroded remnant of the Resurrection plate. Our reconstructions support a "northern option" Farallon ridge geometry and allow up to ~1200 km Chugach terrane translation since Paleocene time, providing a new "tomographic piercing point" for the Baja-British Columbia debate.

GSA Bulletin (2020), https://doi.org/10.1130/B35677.1

https://pubs.geoscienceworld.org/gsa/gsabulletin/article/doi/10.1130/B35677.1/592051/Raising-the-Resurrection-plate-from-an-unfolded

Going with the grains to explain a fundamental tectonic force



Mylonite is a fine-grained, compact metamorphic rock produced by dynamic recrystallization of the constituent minerals resulting in a reduction of the grain size of the rock.

A new study suggests that tiny, mineral grains — squeezed and mixed over millions of years — set in motion the chain of events that plunge massive tectonic plates deep into the Earth's interior.

The theory, proposed by Yale scientists David Bercovici and Elvira Mulyukova, may provide an origin story for subduction, one of the most fundamental forces responsible for the dynamic nature of the planet.

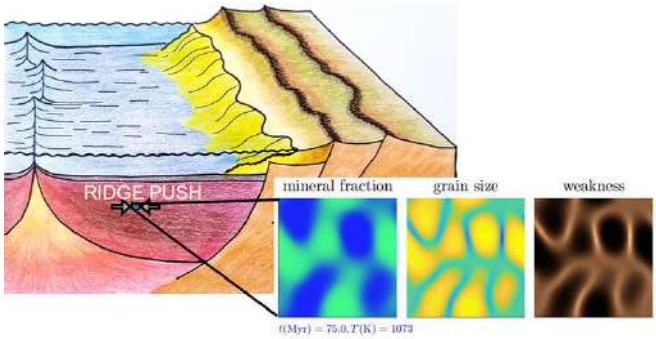
The study appears in the Proceedings of the National Academy of Sciences.

Subduction occurs when one tectonic plate slides underneath another plate and then sinks into the Earth's mantle. Its role in major geological processes is immense: It is the main engine for tectonic motion. It builds mountains, triggers earthquakes, forms volcanoes, and drives the geologic carbon cycle.

Yet researchers have been uncertain about what initiates subduction.

"Why Earth even has subduction, unlike other terrestrial planets as far as we know, is a mystery," said Bercovici, Yale's Frederick William Beinecke Professor and chair of Earth and Planetary Sciences.

"Mantle rock near the surface that has cooled for hundreds of millions of years has two competing effects," he said. "While it's gotten colder and heavier and wants to sink, it's also gotten stiffer and doesn't want to sink. The stiffening effect should win out, as it does on most planets, but on Earth, for some reason, it doesn't."



A conceptual sketch of the ocean basin setting for the new model. Inset images from a computer model show mineral fraction, grain size, and weakness.

According to the theoretical model developed by Bercovici and Mulyukova, a research scientist at Yale, subduction may initiate at the margins between Earth's sea floor and continents.

The model shows that tectonic stresses in an oceanic plate cause its mineral grains to mix with each other, become damaged, and eventually shrink. Over a period of approximately 100 million years, this process weakens the oceanic plate and makes it susceptible to vertical shear and bending — which are associated with the start of subduction.

"The real bottleneck for tectonic plate activity on a terrestrial planet is how fast its massive, rocky layers can deform," said Mulyukova. "The rocks can deform only as fast as their tiny mineral grains allow. Our model explains how these changes in mineral grains can dramatically weaken the rock and make subduction possible on a planet like Earth."

This research was supported by a grant from the National Science Foundation.

(Jim Shelton / YaleNews, January 18, 2021, https://news.yale.edu/2021/01/18/going-grains-explain-fundamental-tectonic-force)

Evolution and demise of passive margins through grain mixing and damage

David Bercovici and Elvira Mulyukova

Significance

Subduction of sea floor into the Earth's mantle is the engine of plate tectonics. Yet, how subduction initiates remains a mystery. Subduction often occurs along trenches at the ocean–continent margin, which implies they formed there, when the margin was once immobile or passive, but then collapsed. Margin collapse occurs when near-surface mantle, the lithosphere, gets cold and heavy and founders. That cold lithosphere, however, should be too stiff to sink. Grain damage in mantle rocks, whereby mineral grains under stress diminish in size, weakens the lithosphere and mostly occurs where minerals mix with each other. Horizontal compressive stresses in a passive margin induce mixing and damage and

generate weak bands in the lithosphere that facilitate subduction initiation.

Abstract

How subduction—the sinking of cold lithospheric plates into the mantle—is initiated is one of the key mysteries in understanding why Earth has plate tectonics. One of the favored locations for subduction triggering is at passive margins, where sea floor abuts continental margins. Such passive margin collapse is problematic because the strength of the old, cold ocean lithosphere should prohibit it from bending under its own weight and sinking into the mantle. Some means of mechanical weakening of the passive margin are therefore necessary. Spontaneous and accumulated grain damage can allow for considerable lithospheric weakening and facilitate passive margin collapse. Grain damage is enhanced where mixing between mineral phases in lithospheric rocks occurs. Such mixing is driven both by compositional gradients associated with petrological heterogeneity and by the state of stress in the lithosphere. With lateral compressive stress imposed by ridge push in an opening ocean basin, bands of mixing and weakening can develop, become vertically oriented, and occupy a large portion of lithosphere after about 100 million y. These bands lead to anisotropic viscosity in the lithosphere that is strong to lateral forcing but weak to bending and sinking, thereby greatly facilitating passive margin collapse.

Proceedings National Academy of Sciences (PNAS) January 26, 2021 118 (4) e2011247118;
https://doi.org/10.1073/pnas.2011247118

Edited by David L. Kohlstedt, University of Minnesota, Minneapolis, MN, and approved December 10, 2020 (received for review June 1, 2020)

https://www.pnas.org/content/118/4/e2011247118

The Atlantic Ocean is widening. Here's why.

The Atlantic is expanding by a couple of inches a year.

The Atlantic Ocean is getting wider, shoving the Americas to one side and Europe and Africa to the other. But it's not known exactly how.

A new study suggests that deep beneath the Earth's crust, in a layer called the mantle, sizzling-hot rocks are rising up and pushing on tectonic plates — those rocky jigsaw pieces that form Earth's crust — that meet beneath the Atlantic.

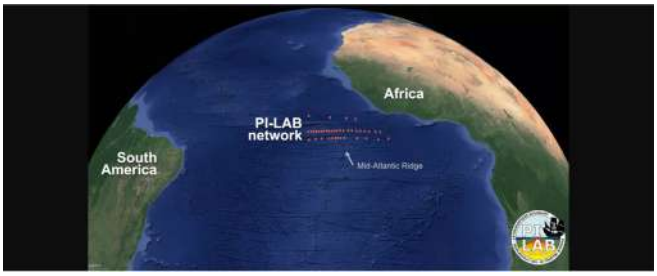
Previously, scientists thought that the continents were mostly being pulled apart as the plates beneath the ocean moved in opposite directions and crashed into other plates, folding under the force of gravity. But the new study suggests that's not the whole picture.

The research began in 2016, when a group of researchers set sail on a research vessel to the widest part of the Atlantic Ocean between South America and Africa; in other words, to "the middle of nowhere," said lead author Matthew Agius, who was a postdoctoral researcher with the University of Southampton in the U.K. at the time, but is now at the Roma Tre University in Italy.

The spot is not a particularly popular route for travel, Agius said, noting that sometimes days would go by without seeing a single other ship or a plane. Interaction is limited to the occasional whales and dolphins that swim by and a fleeting signal from the ship's Wi-Fi. Lightless nights blanket the vast sea in an unobscured view of the galaxy and stars — and it's very, very quiet, Agius said.

But this vast, empty stretch of ocean rests upon an incredibly important geological spot: the mid-Atlantic ridge, the planet's largest tectonic boundary that extends 10,000 miles (16,093 kilometers) from the Arctic Ocean to to the southern tip of Africa. This is the spot where the South American and the North American Plates move apart from the Eurasian and African plates, at a speed of about 1.6 inches (4 centimeters) a year, extending the Atlantic Ocean.

The planet we live on is a remarkable place. But have you ever wondered how or why these things occur? How the Earth was made? How we predict the weather? How fossils form? What causes earthquakes or which animals glow in the dark? "Incredible Earth" reveals answers to these questions and more on a thrilling journey through everything you need to know about our world — and with gorgeous photography and insightful diagrams along the way!



39 seismometers were places across a span of hundreds of miles on the Mid-Atlantic Ridge.

Listening to rumbles

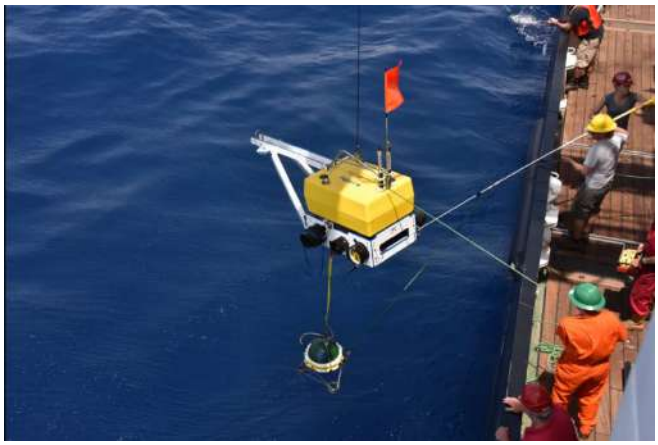
Agius and his team spent five weeks sailing across a small portion of the ridge — about 621 miles (1,000 km) — dropping seismometers (instruments that detect seismic waves or vibrations such as those from earthquakes) onto the seafloor.

A year later, the researchers collected the seismometers.

Until now, "we never had good images of what's happening beneath the ocean," Agius said. Since seismic waves behave differently depending on the material they move through, the researchers could use the data to create images, allowing them to peer into various layers of the Earth. In that year of listening, the seismometers picked up vibrations from earthquakes that propagated from various parts of the world and through Earth's deep mantle — a layer of mostly solid, hot rock about 1,800 miles (2,900 km) thick.

While the team's original goal was to learn about how the plates were born and how they aged, and they really intended

to study shallower depths of the Earth, the researchers found evidence of a deeper phenomenon at play.

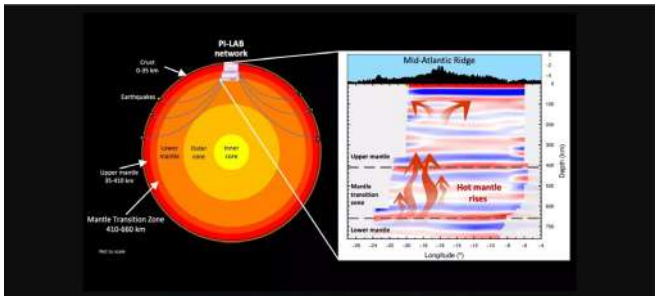


A seismometer being deployed into the ocean at the Mid-Atlantic Ridge.

They found that in that area within the ridge, the mantle transition zone — a higher-density region that serves as a gatekeeper between the upper and lower layers of the mantle — was thinner than average which likely means it was hotter than normal. The hotter temperatures of the transition zone likely facilitated an "upwelling" of hot rock from Earth's lower mantle to its upper mantle that actively pushed the plates apart, Agius said.

Researchers previously thought that plates mainly diverged from each other due to a "pulling" at subduction zones, places where plates collide and one sinks beneath the other, recycling material into the mantle, Agius said. So if you have one plate being pulled on one side (and crashing with another plate at a subduction zone), and another plate being pulled to the other side (again crashing with another plate at a subduction zone), it would create ridges in the middle, where the hot material from below rises to fill the resulting gap.

"That is still happening, but it was thought that the ridges are an effect of that process," he said. But their findings suggest that as subduction zones pull the plates apart, upwellings beneath the ridges might be actively helping to push them apart. However, it's unclear if this process is just related to the mid-Atlantic ridge or if all the ridges around the world experience the same thing, Agius said. "The pulling is still there, just we would like to determine now if all the ridges are experiencing pushing as well."



Seismic waves from earthquakes travel deep inside the Earth and are recorded on the seismometers. Analysis of that data allowed researchers to image the inside of our planet and find that the mantle transition zone was thinner than average. That suggests it's hotter than average likely prompting material to move from the lower mantle to the upper mantle and pushing on the tectonic plates above.

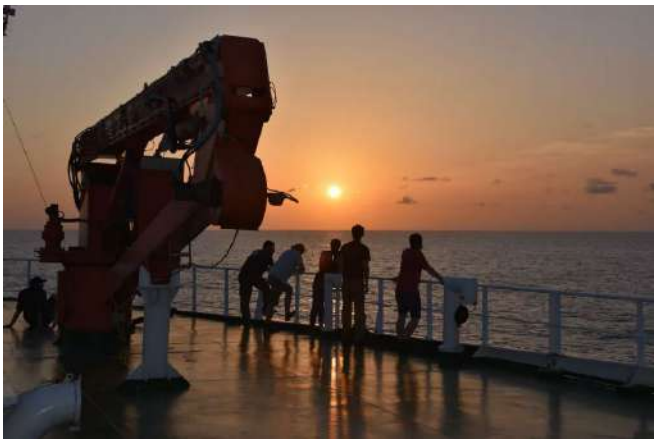
Pushing and pulling

"The findings "add a piece of the puzzle towards understanding flow in Earth's mantle," said Jeroen Ritsema, a professor in the department of Earth and Environmental Sciences at the University of Michigan, who was not a part of the study.

And though their analysis is "excellent," the study is limited in scope, he said. They looked at only a small portion of the Atlantic seafloor, so it's not clear if their findings would hold true along the entire mid-Atlantic ridge or even in other mid-ocean ridges. "It is difficult to infer global-scale rock flow in Earth's mantle from only a single viewpoint," Ritsema told Live Sceince. "It is like peeking through a keyhole and trying to find out what furniture is in the living room, kitchen and the bedrooms upstairs."

What's more, there could be some other explanations for the warmer-than-normal transition zone.

It's a very "remarkable data set that they collected at great pains," said Barbara Ramonowicz, a professor of the University of California, Berkeley's Earth and Planetary Science Graduate School and professor emeritus of the College de France in Paris, who was also not a part of the study. "I have no doubt about their analysis. ...I have reservations about their interpretation," Ramonowicz told LiveScience. There are well-known plumes nearby that could have been offset and caused that area to heat up, she said.



The crew on the research vessel looking out at an ocean sunset.

Vedran Lekic, an associate professor at the University of Maryland's Department of Geology who was also not involved with the study, agrees that their explanation is plausible "but not the only possible one to explain the findings." But if the findings are replicated elsewhere, it "might bring into question our prevailing view of ridges," he added.

These and other similar findings could also alter our maps. Some 300 million years ago, all seven continents were smooshed together into a single supercontinent known as Pangaea. Over millions of years, plates split the continents, creating ocean boundaries and the modern map. But the spreading of the Atlantic Ocean and the shrinking of the Pacific Ocean is slowly, inconspicuously aging those maps and making them increasingly inaccurate. "The maps will alter a little bit [for now] and over millions and millions of years will alter significantly," Agius said.

The findings were published in the journal Nature on Jan. 27.

Originally published on Live Science.

(Yasemin Saplakoglu - Staff Writer / LIVESCIENCE, Jan. 28, 2021, https://www.livescience.com/atlantic-ocean-widening-mantle-upwelling.html)

A thin mantle transition zone beneath the equatorial Mid-Atlantic Ridge

Matthew R. Agius, Catherine A. Rychert, Nicholas Harmon, Saikiran Tharimena & J.-Michael Kendall

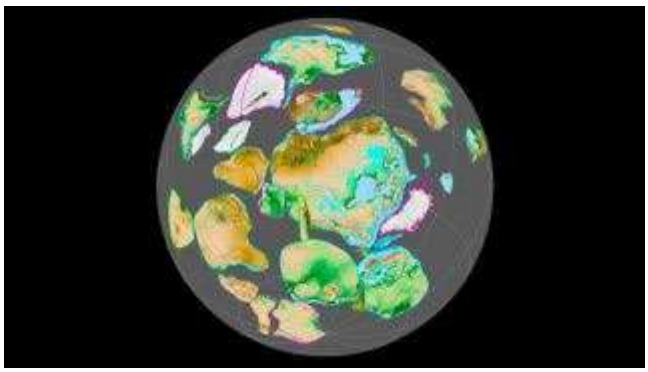
Abstract

The location and degree of material transfer between the upper and lower mantle are key to the Earth's thermal and chemical evolution. Sinking slabs and rising plumes are generally accepted as locations of transfer, whereas mid-ocean ridges are not typically assumed to have a role. However, tight constraints from in situ measurements at ridges have proved to be challenging. Here we use receiver functions that reveal the conversion of primary to secondary seismic waves to image the discontinuities that bound the mantle transition zone, using ocean bottom seismic data from the equatorial Mid-Atlantic Ridge. Our images show that the seismic discontinuity at depths of about 660 kilometres is broadly uplifted by 10 ± 4 kilometres over a swath about 600 kilometres wide and that the 410-kilometre discontinuity is depressed by 5 ± 4 kilometres. This thinning of the mantle transition zone is coincident with slow shear-wave velocities in the mantle, from global seismic tomography. In addition, seismic velocities in the mantle transition zone beneath the Mid-Atlantic Ridge are on average slower than those beneath older Atlantic Ocean seafloor. The observations imply material transfer from the lower to the upper mantle—either continuous or punctuated—that is linked to the Mid-Atlantic Ridge. Given the length and longevity of the mid-ocean ridge system, this implies that whole-mantle convection may be more prevalent than previously thought, with ridge upwellings having a role in counterbalancing slab downwellings.

Nature **volume 589**, pages 562–566 (2021),
https://www.nature.com/articles/s41586-020-03139-x

Earth's mountains disappeared for a billion years, and then life stopped evolving

A dead supercontinent may be to blame.



The supercontinent of Nuna-Rodinia broke up at the end of the Proterozoic era, ending a billion years of no new mountain formation, a new study says.

Earth, like so many of its human inhabitants, may have experienced a mid-life crisis that culminated in baldness. But it wasn't a receding hairline our planet had to worry about; it was a receding skyline.

For nearly a billion years during our planet's "middle age" (1.8 billion to 0.8 billion years ago), Earth's mountains literally stopped growing, while erosion wore down existing peaks to stumps, according to a study published Feb. 11 in the journal Science.

This extreme mountain-forming hiatus — which resulted from a persistent thinning of Earth's continental crust — coincided with a particularly bleak eon that geologist's call the "boring billion," the researchers wrote. Just as Earth's mountains failed to grow, the simple life-forms in Earth's oceans also failed to evolve (or at least, they evolved incredibly slowly) for a billion years.

According to lead study author Ming Tang, the mountain of trouble on Earth's continents may have been partially responsible for the slow going in Earth's seas.

"Continents were mountainless in the middle age," Tang, an assistant professor at Peking University in Beijing, China, told Live Science in an email. "Flatter continents may have reduced nutrient supply [to the ocean] and hindered the emergence of complex life."

When mountains vanish

At the convergent boundaries where Earth's continental plates clash, mountains soar upward in a process called orogenesis. The continental crust at these boundaries is thicker on average and buoyed by magma, lifting surface rocks up to dizzying heights. Meanwhile, erosion and gravity push back against the peaks; when the tectonic and magmatic processes below the surface stop, erosion wins out, whittling mountains away.

Because even the mightiest mountains disappear over time, studying ancient Earth's crustal thickness can be the best way to gauge how actively mountains formed in the past. To do that, the study authors analyzed the changing composition of zircon minerals that crystallized in the crust billions of years ago.

Today, tiny grains of zircon are easily found in sedimentary rocks all over the planet's surface. The precise elemental composition of each grain can reveal the conditions in the crust where those minerals first crystallized, eons ago.

"Thicker crust forms higher mountains," Tang said. Crustal thickness controls the pressure at which magma changes composition, which then gets recorded by anomalies in zircons crystallizing from that magma, he added.

In a previous study published in January in the journal Geology, Tang and colleagues found that the amount of europium embedded in zircon crystals could reveal crust thickness at the time those crystals formed. More europium signifies higher pressure placed on the crystal, which signifies thicker crust above it, the researchers found.

Now, in their new study in Science, the researchers analyzed zircon crystals from every content, and then used those europium anomalies to construct a history of continental thickness going back billions of years. They found that "the average thickness of active continental crust varied on billion-year timescales," the researchers wrote, with the thickest crust forming in the Archaean eon (4 billion to 2.5 billion years ago) and the Phanerozoic (540 million years ago to the present).

Right between those active mountain-forming eras, crustal thickness plummeted through the Proterozoic eon (2.5 billion to 0.5 billion years ago), reaching a low during Earth's "middle age."

The eon of nothing

It may not be a coincidence that Earth's flattest eon on land was also its most "boring" eon at sea, Tang said.

"It is widely recognized by our community that life evolution was extremely slow between 1.8-0.8 billion years ago," Tang told Live Science. "Although eukaryotes emerged 1.7 billion years ago, they only rose to dominance some 0.8 billion years ago."

By contrast, Tang said, the Cambrian explosion, which occurred just 300 million years later, introduced almost all major animal groups that we see today. For whatever reason, life evolved achingly slowly during the "boring billion," then jump-started just as the crust began thickening.

What's the correlation? If no new mountains formed during this period, then no new nutrients were introduced to Earth's surface from the mantle below, the researchers wrote — and a dearth of nutrients on land also meant a dearth of nutrients making their way into the ocean through the water cycle. As mountain forming stalled for a billion years, a "famine" of phosphorus and other essential elements could have starved Earth's simple sea critters, limited their productivity and stalled their evolution, the team suggests.

Life, and mountains, eventually flourished again when the supercontinent Nuna-Rodinia broke apart at the end of the Proterozoic eon. But before then, this gargantuan continent may have been so massive that it effectively altered the structure of the mantle below, stalling plate tectonics during the "boring billion" and resulting in an eon of crustal thinning, the researchers wrote. But further research is needed to fully solve the mystery of Earth's vanishing mountains.

(Brandon Specktor - Senior Writer / LIVESCIENCE, 11 February 2021, https://www.livescience.com/earth-mountains-disappear-boring-billion.html)

Orogenic quiescence in Earth's middle age

Ming Tang, Xu Chu, Jihua Hao, Bing Shen

A boring billion for mountains

Earth's crust has changed over time as supercontinents formed and broke apart. Tied into this cycle are the building and erosion of high mountains, which are tied to collisions between tectonic plates. Tang *et al.* use europium anomalies in zircons to estimate the mean thickness of crust over Earth's history. This proxy shows that mountain building has not always been as active as it is today or as it was very early in Earth's history. Mountain building, and the subsequent erosion, was less intense for about a billion years, roughly correlated with a so-called "boring billion" period of biological evolution.

Abstract

Mountain belts modulate denudation flux and hydrologic processes and are thus fundamental to nutrient cycling on Earth's surface. We used europium anomalies in detrital zircons to track mountain-building processes over Earth's history. We show that the average thickness of active continental crust varied on billion-year time scales, with the thickest crust formed in the Archean and Phanerozoic. By contrast, the Proterozoic witnessed continuously decreasing crustal thickness, leaving the continents devoid of high mountains until the end of the eon. We link this gradually diminished orogenesis to the long-lived Nuna-Rodinia supercontinent, which altered the mantle thermal structure and weakened the continental lithosphere. This prolonged orogenic quiescence may have resulted in a persistent famine in the oceans and stalled life's evolution in Earth's middle age.

Science 12 Feb 2021: Vol. 371, Issue 6530, pp. 728-731, DOI: 10.1126/science.abf1876

(https://science.sciencemag.org/content/371/6530/728)

Researchers Use Whale Calls to Probe Undersea Geology

The study finds that fin whale songs are powerful enough to reverberate through the Earth's crust, allowing scientists to study its thickness and structure

Fin whale songs are some of the loudest animals in the ocean, producing calls that can reach 189 decibels and are almost as loud as container ships.

Whale songs suffuse the ocean depths with waves of sound that can travel thousands of miles. Now, scientists have figured out they can use the whales' underwater serenades to study the seafloor, reports Robin George Andrews for the *New York Times*.

To study the Earth's crust beneath the oceans, scientists use the way vibrations travel through the layers of sediment and rock to decipher details about their composition and structure. But crust-rattling vibrations like that don't come around every day. Traditionally, researchers have had to wait for jolts of tectonic activity to generate seismic vibrations, but undersea earthquakes aren't always reliable collaborators. Alternately, scientists have resorted to making their own vibrations by blasting air guns from ships at sea, a technique that is also used by the oil and gas industry to search for deposits of fossil fuels. Air guns produce powerful seismic waves that generate high resolution images of the sea floor, but using them is expensive and the harsh noise can harm sea life sensitive to sound.

The new study, published last week in the journal *Science*, detected the calls of fin whales, one of the loudest creatures in the sea, via 54 ocean-bottom seismometers that were poised to detect undersea quakes. Unexpectedly, the researchers found that the fin whales' vocalizations were powerful enough to reverberate through the Earth's crust.

"The calls travel through the water and penetrate into the ground," Václav Kuna, a seismologist at the Czech Academy of Sciences and co-author of the research, tells Karina Shah of *New Scientist*. "They then bounce off the layers within the oceanic crust and come back to the surface where we record them."

Between 2012 and 2013, four of the seismometers stationed in the northeast Pacific Ocean recorded six fin whale songs ranging from 2.5 to almost 5 hours in length. The whale chatter translated to seismic waves powerful enough to allow Kuna and his colleagues to peer 8,200 feet below the ocean bottom, according to the *Times*. Fin whale calls can reach 189 decibels, reports Carolyn Gramling for *Science News*, which is nearly equal to the maritime din of a container ship.

These recordings suggest whale songs could be used as a way to estimate the varying thickness and geology of the Earth's crust without waiting for tectonic activity or motoring noisy air guns out to sea.

"Air guns produce noise pollution in the ocean. It's very expensive and it is not environmentally friendly," Kuna tells *New Scientist*.

In the region the whale songs were picked up, the calls revealed an upper sedimentary layer ranging from around 1,300 to 2,100 feet thick sitting on top of a rocky layer of basalt more than a mile thick that was in turn undergirded by a type of oceanic rock called gabbro.

Unfortunately, air guns are still tops in terms of the geologic resolution they provide, with whale songs producing weaker seismic waves. "It's never going to replace air guns," Kuna tells the *Times*. "But it is a complement. And it's free."

Speaking with Sofia Moutinho of *Science*, Kuna says he's hoping other researchers can apply the technique for other types of studies. "This study was a proof of a concept," he tells *Science*. "I'm putting it out there for other people to find more uses for this."

(Alex Fox / SMITHSONIAN MAGAZINE – SmartNews, February 16, 2021, https://www.smithsonianmag.com/smart-news/researchers-use-whale-calls-probe-undersea-geology-180977022)

Extending full-plate tectonic models into deep time: Linking the Neoproterozoic and the Phanerozoic

Andrew S. Merdith, Simon E. Williams, Alan S. Collinsc, Michael G. Tetleya, Jacob A. Mulderd, Morgan L. Bladesc, Alexander Younge, Sheree E. Armisteadf, John Cannong, Sabin Zahirovicg, R. Dietmar Müllerg

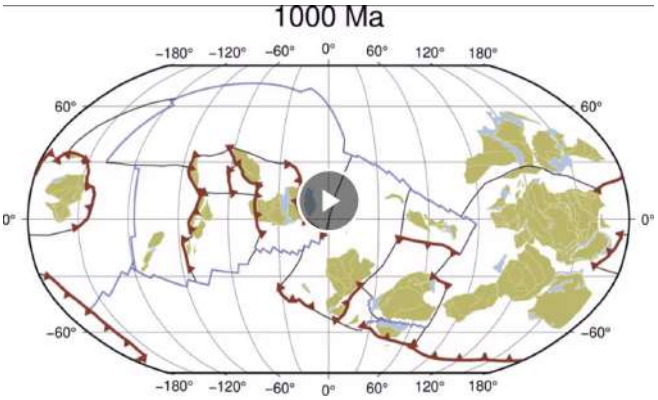
Abstract

Recent progress in plate tectonic reconstructions has seen models move beyond the classical idea of continental drift by attempting to reconstruct the full evolving configuration of tectonic plates and plate boundaries. A particular problem for the Neoproterozoic and Cambrian is that many existing interpretations of geological and palaeomagnetic data have remained disconnected from younger, better-constrained periods in Earth history. An important test of deep time reconstructions is therefore to demonstrate the continuous kinematic viability of tectonic motions across multiple supercontinent cycles. We present, for the first time, a continuous full-plate model spanning 1 Ga to the present-day, that includes a revised and improved model for the Neoproterozoic–Cambrian (1000–520 Ma) that connects with models of the Phanerozoic, thereby opening up pre-Gondwana times for quantitative analysis and further regional refinements. In this contribution, we first summarise methodological approaches to full-plate modelling and review the existing full-plate models in order to select appropriate models that produce a single continuous model. Our model is presented in a palaeomagnetic reference frame, with a newly-derived apparent polar wander path for Gondwana from 540 to 320 Ma, and a global apparent polar wander path from 320 to 0 Ma. We stress, though while we have used palaeomagnetic data when available, the model is also geologically constrained, based on preserved data from past-plate boundaries. This study is intended as a first step in the direction of a detailed and self-consistent tectonic reconstruction for the last billion years of Earth history, and our model files are released to facilitate community development.

Earth-Science Reviews, Volume 214, March 2021, 103477, https://doi.org/10.1016/j.earscirev.2020.103477

https://www.sciencedirect.com/science/article/abs/pii/S0012825220305237

The first full plate tectonic reconstruction of the world over the last BILLION years - Merdith et al 2021, Earth-Science Reviews



Alan Collins, Author, Professor of Geology at The University of Adelaide: The animation can be downloaded here https://universityofadelaide.box.com/s/jnq2gd4nn5icy3dol7dv276qrpadrtss

Lybian Trovants

They're located in Kawakeb Valley in the Kafra region of Lybia.

Trovants are outlandish geological formations of a mysterious nature that have sparked the imagination of those studying them over the ages.

These unusual stones have abilities that set them apart from mostly all naturally occurring rocks.

Believe it or not, they grow constantly and form into shapes that ignite your wildest imagination.

They are made of a special alloy or cement that makes them "move" and "multiply."

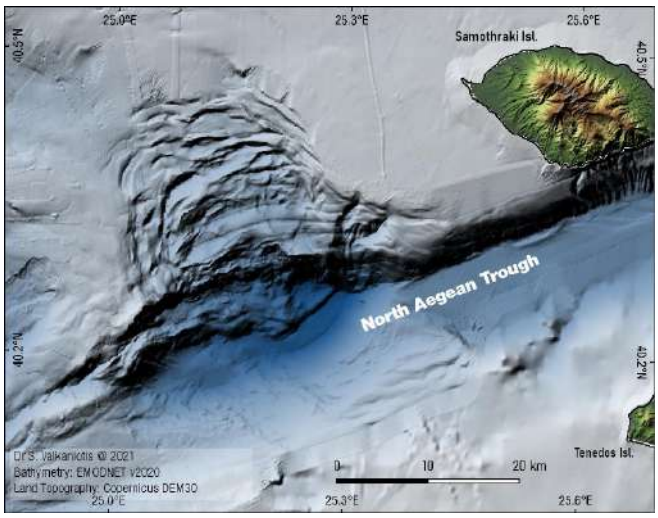
Some of them, when cut in half, were found to have concentric rings like those of trees.

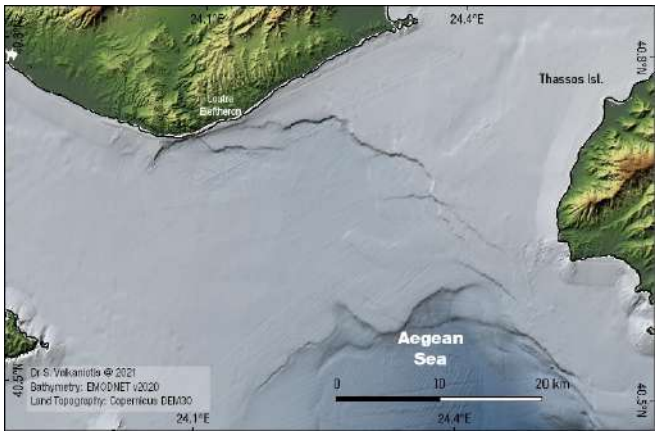
For these reasons, trovants were dubbed the "living" and "moving" stones.

Studies to determine their true nature began as early as the 19th century.

New goodies from the updated [2020] version of EMODNET bathymetry

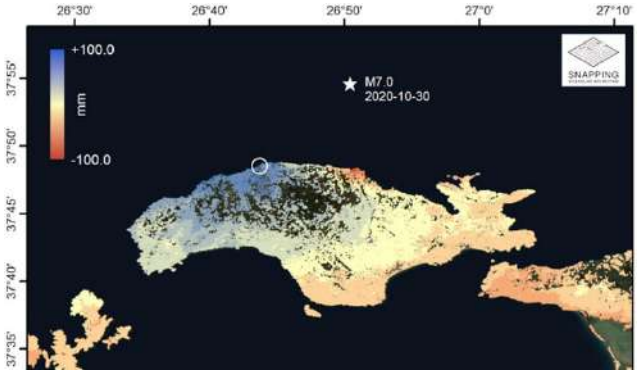
A huge collapse structure along the North Aegean Trough and a previously unkown offshore normal fault zone between Ierisssos Gulf and Thassos isl.





(Sotiris Valkaniotis, Feb 19, 2021, https://twitter.com/SotisValkan/status/1362709877546713088)

ΑΠΘ: Ερευνητές δείχνουν τις μετακινήσεις του εδάφους από σεισμούς, κατολισθήσεις και εκρήξεις ηφαιστείων



Από τη Σάμο ως στο Μεξικό κι από τη Διώρυγα του Σουέζ μέχρι την Ινδονησία και το ηφαίστειο της Σαντορίνης πληροφορίες που έρχονται από δορυφόρους 700 χιλιόμετρα πάνω από τη Γη δίνουν απαντήσεις για τις μετακινήσεις του εδάφους, οι οποίες προκαλούνται από σεισμούς, κατολισθήσεις, καθιζήσεις, ηφαιστειακές εκρήξεις, ενώ αποτυπώνουν εδαφικές παραμορφώσεις από μεγάλα τεχνικά έργα ή ακόμη και την αστάθεια κτιρίων.

Πηγή: ΑΠΕ-ΜΠΕ

Επιστήμονες του Αριστοτελείου Πανεπιστημίου Θεσσαλονίκης συνεργάστηκαν με τον Ευρωπαϊκό Οργανισμό Διαστήματος (ΕΟΔ) και συναδέλφους τους από άλλες χώρες της Ευρώπης και κατάφεραν να δημιουργήσουν μία διαδικτυακή υπηρεσία, μέσω της οποίας υπολογίζονται οι ακριβείς μετρήσεις εδαφικών μικρομετακινήσεων από δορυφορικά δεδομένα, με τη λεγόμενη τεχνική της Συμβολομετρίας Σταθερών Ανακλαστήρων (Persistent Scatterer Interferometry - PSI).

Πρακτικά οι εικόνες που έρχονται από τους δορυφόρους βοηθούν τους επιστήμονες να αναγνωρίσουν τις παραμορφώσεις του εδάφους, όπως την κλίση ενός ρήγματος, την εξέλιξή του, και να εντοπίσουν τους γεωκινδύνους ακόμη και μέσα σε αστικό ιστό. Τα δεδομένα που προκύπτουν από την επεξεργασία των εικόνων και των αλγορίθμων είναι τελικά διαθέσιμα μέσω ενός εύχρηστου εργαλείου σε ερευνητές, στην Πολιτεία, στις υπηρεσίες Πολιτικής Προστασίας και σε κάθε ενδιαφερόμενο που ασχολείται με την εξέλιξη των γεωλογικών φαινομένων.

Η υπηρεσία που αναπτύχθηκε από ομάδα με επικεφαλής τον επίκουρο καθηγητή του Τμήματος Γεωλογίας του ΑΠΘ Μιχάλη Φουμέλη φέρει την ονομασία «SNAPPING» (Surface motioN mAPPING) και αξιοποίησε δορυφορικά δεδομένα ραντάρ από τη δορυφορική αποστολή Copernicus Sentinel-1. Είναι διαθέσιμη μέσω της πλατφόρμας GEP (Geohazards Exploitation Platform), η οποία αποτελεί μία πρωτοβουλία του Ευρωπαϊκού Οργανισμού Διαστήματος και χρησιμοποιείται παγκοσμίως, από περισσότερους από 80 οργανισμούς σε 32 χώρες.

«Η μεθοδολογία σταθερών ανακλαστήρων έχει αναπτυχθεί τα τελευταία χρόνια και δίνει ακρίβειες χιλιοστών από απόσταση 700 χιλιόμετρων, όπου βρίσκεται ο δορυφόρος στο διάστημα. Αυτή η τεχνική δεν είναι σε πειραματικό επίπεδο, έχει δοκιμαστεί, έχει αποδείξει την αξία της. Έχουμε κάνει συσχετίσεις και με άλλες τεχνικές και είναι αποδεκτή ως τακτική παρακολούθηση», δήλωσε στο ΑΠΕ-ΜΠΕ ο κ. Φουμέλης, εξηγώντας ότι οι μετρήσεις των εδαφικών μετακινήσεων «πιάνουν» ετήσια ταχύτητα ενός σημείου της τάξης του 1-2 χιλιοστών ανά έτος.

«Ηγηθήκαμε μίας προσπάθειας μαζί με άλλα πανεπιστήμια και πλέον ενσωματώσαμε την υπηρεσία στην πλατφόρμα GEP (https://geohazards-tep.eu) του Ευρωπαϊκού Οργανισμού Διαστήματος, κάτι που συνιστά μεγάλη επιτυχία», επισήμανε ο κ. Φουμέλης για την καινοτομία και πρωτοπορία που εισήγαγε η ομάδα του, απλοποιώντας την πρόσβαση των χρηστών σε πληροφορίες που μέχρι τώρα ήταν δυσπρόσιτες στους περισσότερους, λόγω τεράστιου όγκου και πολυπλοκότητας των δεδομένων που θα απαιτούσαν μεγάλη χωρητικότητα και επεξεργαστική ισχύ υπολογιστών.

«Επιτρέπουμε πολύ πιο εύκολη πρόσβαση ακόμη και σε μη ειδικούς. Αυτή τη στιγμή ένας που θα χρησιμοποιήσει την πλατφόρμα δε χρειάζεται να τρέξει κάποιον περίπλοκο αλγόριθμο, αλλά έχει άμεσα πρόσβαση στα δορυφορικά δεδομένα, αυτόματη ανάκτηση πληροφορίας για εδαφικές παραμορφώσεις της περιοχής που θα ζητήσει. Από το 2014 και μετά σε οποιαδήποτε περιοχή μπορεί να αναζητήσει κανείς τι συμβαίνει με μικρομετακινήσεις, κατολισθήσεις και άλλα φαινόμενα», πρόσθεσε ο κ. Φουμέλης.

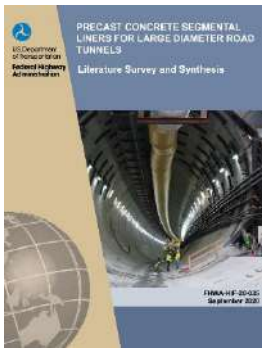
Έπειτα από πολλές επιτυχείς δοκιμές και βελτιστοποιήσεις η υπηρεσία βρίσκεται πλέον σε πλήρη λειτουργία. Στον πρόσφατο ισχυρό σεισμό στη Σάμο μέσω της υπηρεσίας καταγρά-

φηκε η μετακίνηση του εδάφους και η εξέλιξη της εδαφικής παραμόρφωσης στον χρόνο, δόθηκαν σημαντικές πληροφορίες για το ρήγμα που προκάλεσε τον σεισμό, τη μετασεισμική δραστηριότητα, καθώς και για σημαντικά δευτερογενή φαινόμενα, όπως κατολισθήσεις (https://eo4society.esa.int/2021/02/04/new-psi-service-snapping-operational-on-the-gep).

«Αν ο σεισμός της Σάμου γίνονταν πριν από το 2014, πρώτο έτος ελεύθερης διάθεσης των δορυφορικών δεδομένων Copernicus, θα απαιτούνταν πολύτιμος χρόνος για την εξαγωγή αντίστοιχων αποτελεσμάτων που σήμερα με την προηγμένη υπηρεσία SNAPPING αυτό γίνεται πολύ πιο σύντομα, με λιγότερο κόπο και κόστος» σημείωσε ο κ. Φουμέλης.

(real.gr, 15Φεβρουαρίου 2021, https://www.real.gr/texnologia/arthro/apth_ereunites_deixnoun_tis_metakiniseis_tou_edafous_apo_seismous_katolisthiseis_kai_ekrikseis_ifaisteion-714403/)

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ



Precast Concrete Segmental Liners for Large Diameter Road Tunnels

Literature Survey and Synthesis

William Bergeson, Sotirios Vardakos, Michael Mooney, Axel Nitschke

Increased roadway traffic demands have led to a notable increase of large diameter tunnel boring machine-driven tunnels across the world. The technological advancements of tunnel boring machines have made them a viable technical option for tunneling in difficult conditions in urban environments at ever increasing diameters. Such tunnels utilize precast concrete segmental linings. Although precast concrete segments have been widely used and designed in the US since the mid-1970s, the significant increase in diameter demands brings about new challenges in design and construction. Various international publications and practice manuals have been authored about segmental lining design. The present document is the first phase of an FHWA research initiative focused on the design of large diameter precast concrete segmental linings. This document provides an overview of the literature survey and synthesizes the current state of the practice along with raising potential knowledge gaps for future research.

Precast Concrete Segmental Liners for Large Diameter Road Tunnels (September 2020). You can download it here: https://lnkd.in/gEHrQmk

(Federal Highway Administration U.S. Department of Transportation, September 2020)

Recommended Options for Improving the Built Environment for Post-Earthquake Reoccupancy and Functional Recovery Time

NIST-FEMA Special Publication FEMA P-2090/NIST SP-1254

Executive Summary

The most recent reauthorization of the National Earthquake Hazards Reduction Program (NEHRP), P.L. 115-307, includes a heightened focus on achieving community resilience and a new requirement for the National Institute of Standards and Technology (NIST) and the Federal Emergency Management Agency (FEMA) to jointly convene a Committee of Experts to assess and recommend options for improving the built environment and critical infrastructure to reflect performance goals stated in terms of post-earthquake reoccupancy and functional recovery time.

To comply with this mandate, NIST and FEMA developed a plan of action in which FEMA funded a Project Technical Panel, responsible for report development, and NIST funded a Project Review Panel, responsible for report review. The Committee of Experts consisted of the Project Technical Panel, with 17 outside experts and representation from all interest groups named in the reauthorization, and the Project Review Panel, with 10 outside experts and similar representation. To facilitate national-level stakeholder interaction, NIST hosted five stakeholder workshops that were used to gather additional information and feedback.

This report provides a set of options in the form of recommendations, tasks, and alternatives for improving the built environment, which have been developed and assessed by the Committee of Experts. It describes community resilience, defines the concepts of reoccupancy and functional recovery, and explains the relationship among these three ideas. It explains why reoccupancy and functional recovery concepts are needed, describes a target performance state, and identifies potential cost and benefits associated with implementing enhanced seismic design. To fulfill the Congressional mandate, this report addresses the issue of functional recovery for seismic hazard. Although this report does not discuss the unique challenges associated with improving functional recovery for other hazards, recommendations in this report could be leveraged and adapted for other natural hazards.

The motivation for this report is the risk that the United States faces each year from all forms of natural hazards, including hurricanes, floods, wildfires, and earthquakes. Natural hazard events can affect communities through damage that results in injury and loss of life, interruption of lifeline services, displacement of residents and businesses, and economic and socio-cultural impacts. Almost half of the U.S. population – 150 million people – reside in portions of 42 states that are at risk of experiencing a damaging earthquake within the next 50 years. Earthquakes have caused disastrous impacts in the past and are expected to cause more in the future. In regions of high seismic risk where an earthquake hasn't occurred for some time, scenario studies predict deaths in the thousands, injuries in the tens of thousands, and hundreds of billions of dollars in direct economic losses, along with long-term, destabilizing impacts to community function.

…

This publication is available free of charge from:
https://doi.org/10.6028/NIST.SP.1254
or by calling FEMA at 1-800-480-2520

(Final Report, January 2021)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

International Society for Soil Mechanics and Geotechnical Engineering

ISSMGE News & Information Circular
February 2021
www.issmge.org/news/news-and-information-circular-february-2021

1. 20ICSMGE / 7iYGEC – NEW DATES – MAY 2022

New dates have been confirmed for the conferences in Sydney as follows;

7iYGEC - Friday 29 April-Sunday 1 May 2022

20ICSMGE – Sunday 1 May – Thursday 5 May 2022

For more information, please visit the conference website (https://icsmge2021.org/ - currently being updated).

2. BULLETIN

The latest edition of the ISSMGE Bulletin (Volume 14, Issue 6, December 2020) is available from the website https://www.issmge.org/publications/issmge-bulletin/vol-14-issue-6-december-20200

3. ISSMGE FOUNDATION

The next deadline for receipt of applications for awards from the ISSMGE Foundation is the 31st May 2021. Click **here** for further information on the ISSMGE Foundation.

4. NEWS FROM NAUE – WEBINAR

The next webinar Geosynthetic Clay Liners (GCLs) in comparison to a compacted Clay Liner will take place on Thursday, 11th February at 9:00 CET and will be held by Kent von Maubeuge.

The link for the registration is https://attendee.gotowebinar.com/register/2407574635776422928

5. CONFERENCES

For a listing of all ISSMGE and ISSMGE supported conferences, and full information on all events, including deadlines, please go to the Events page at https://www.issmge.org/events. However, for updated information concerning possible changes due to the coronavirus outbreak (ie. postponements, cancellations, change of deadlines, etc), please refer to that specific event's website.

As might be expected, many events have been rescheduled and we update the Events page whenever we are advised of changes.

The following are events that have been added since the previous Circular:

ISSMGE Events

16th INTERNATIONAL CONFERENCE ON GEOTECHNICAL ENGINEERING, 23-02-2022 - 24-02-2022, University of Engineering & Technology (UET) Lahore, Pakistan; Language: English; Contact information: Dr. Jahanzaib Israr; Department of Civil Engineering, University of Engineering & Technology Lahore; Phone: +923344132808; Email: 16icge@uet.edu.pk; Website: https://16icge.uet.edu.pk/

GEOTECHNICAL ASPECTS OF UNDERGROUND CONSTRUCTION IN SOFT GROUND - TC204, CAMBRIDGE 2022 - 27-06-2022 - 29-06-2022, University of Cambridge, Cambridge, United Kingdom, Language: English; Organiser: University of Cambridge; Contact person: Dr Mohammed Elshafie; Email: me254@cam.ac.uk; Website: https://www.is-cambridge2020.eng.cam.ac.uk

Geo-Trends Review

A Crowdsourcing Magazine for the Geotechnical Engineering Community
Issue #14 - FEBRUARY 2021
hwww.mygeoworld.com/geotrends/issues/14-february-2021

If you want to be part of the first interactive geotechnical magazine start blogging, posting, updating your profile, asking and replying to questions, today!

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Through Geo-Trends, YOU are the author and YOUR message reaches directly thousands of geo-professionals!

Κυκλοφόρησε το IGS Newsletter της International Geosynthetics Society με τα παρακάτω περιεχόμενα:

IGS NEWSLETTER – February 2021

Helping the world understand the appropriate value and use of geosynthetics

httpwww.geosyntheticssociety.org/newsletters

- New Dates For EuroGeo7 READ MORE
- IGS Foundation Website Now Live! READ MORE
- Click For Clay Liners Webinar READ MORE
- Five Lessons Learned From GeoAmericas 2020 READ MORE
- TC-Barriers Workshop, Barcelona, Spain – Jan 2020 READ MORE

- New Chair For UK Chapter READ MORE
- IGS Chapter Focus: Italy READ MORE
- What's In Store For 2021? READ MORE
- Beat The Deadline For 12th ICG Abstracts READ MORE
- Abstracts Invited For GeoAsia7 READ MORE
- Calendar of Events

READ MORE AT GEOSYNTHETICSSOCIETY.ORG

www.icevirtuallibrary.com/toc/jgein/28/1

Κυκλοφόρησε το Τεύχος 1 του Τόμου 28 (Φεβρουαρίου 2021) του Geosynthetics International της International Geosynthetics Society με τα παρακάτω περιεχόμενα:

Healing the world: a geosynthetics solution, N. Touze, 28(1), pp. 1–31

A laboratory device to evaluate geosynthetic load–strain behaviour in MSE walls, F. H. M. Portelinha, M. C. Santos, M. M. Futai, 28(1), pp. 32–47

Practical seismic fragility estimation of unreinforced and reinforced embankments in Japan, M. Shinoda, S. Nakajima, K. Watanabe, S. Nakamura, I. Yoshida, 28(1), pp. 48–64

Linear visco-elastic 1D site response of sand-EPS geofoam layers under cyclic loading, T. Hakimi Basti, R. Jamshidi Chenari, A. Firoozfar, 28(1), pp. 65–79

Role of geotextiles pore size distribution in dewatering tests, N. Fatema, S. Bhatia, 28(1), pp. 80–94

Numerical investigation of reinforced soil structures with GRS-IBS design features, F. Gebremariam, B. F. Tanyu, E. Güler, G. S. Urgessa, P. Shen, 28(1), pp. 95–112

www.sciencedirect.com/journal/geotextiles-and-geomembranes/vol/49/issue/1

Κυκλοφόρησε το Τεύχος 1 του Τόμου 49 (Φεβρουαρίου 2020) του Geotextiles and Geomembrabes της International Geo-synthetics Society με τα παρακάτω περιεχόμενα:

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Geosynthetic-reinforced soils above voids: Observation of soil and geosynthetic deformation mechanisms, T.S. da Silva Burke, M.Z.E.B. Elshafie, Pages 1-18

Experimental investigation of a reinforced soil retaining wall with a flexible geogrid-wrapped ecological bag facing, Junyi Duan, Guolin Yang, Yuliang Lin, Xinting Cheng, Zhihao Dai, Pages 19-31

Examining metal migration through geotextiles during dewatering, H.A. Tackley, C.B. Lake, M. Alimohammadi, Pages 32-40

Experimental study on the multi-impact resistance of a composite cushion composed of sand and geofoam, Peng Zhao, Song Yuan, Liangpu Li, Qi Ge, ... Longhuan Du, Pages 45-56

Modified Broms' method for formation of working platform on very soft soil, Hao Chen, Jian Chu, Wei Guo, Kok Pang Lam, Pages 57-71

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Experimental study of the performance of geosynthetics-reinforced soil walls under differential settlements, Liang Lu, Shuwen Ma, Zongjian Wang, Yi Zhang, Pages 97-108

Experimental study on vacuum preloading consolidation of landfill sludge conditioned by Fenton's reagent under varying filter pore size, Yajun Wu, Yang Xu, Xudong Zhang, Yitian Lu, ... Binjie Song, Pages 109-121

Experimental investigation on the performance of multi-tiered geogrid mechanically stabilized earth (MSE) walls with wrap-around facing subjected to earthquake loading, Amir Mohsen Safaee, Ahmad Mahboubi, Ali Noorzad, Pages 130-145

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Numerical parametric study of geosynthetic reinforced soil integrated bridge system (GRS-IBS), Allam Ardah, Murad Abu-Farsakh, George Voyiadjis, Pages 289-303

A simple solution for prefabricated vertical drain with surcharge preloading combined with vacuum consolidation, Trong Nghia Nguyen, Dennes T. Bergado, Mamoru Kikumoto, Phuoc H. Dang, ... Phu-Cuong Nguyen, Pages 304-322

Soil-reinforcement interaction: Stress regime evolution in geosynthetic-reinforced soils, Amr M. Morsy, Jorge G. Zornberg, Pages 323-342

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