



Natural Resource

April 2020 | Edition 3 | 22nd Year of Publication



Mijnbouwkundige Vereniging
Study Association Applied Earth Sciences



Dear Readers,

Hopefully, by the time you read this, the worst has already passed. Perhaps it is at times like these that we can reflect on how fragile, and at the same time, how strong humans can be. Working together for a common cause is a powerful tool that can achieve great objectives. Together, we will fight this invisible foe, that has been a torment for countless people. This tough moment has affected each one of us differently and we will certainly learn a valuable lesson from it.

Even though most social events in this quarter were cancelled, we were left with some fantastic memories of the half lustrum, which commemorated the 127.5 anniversary of the Mijnbouwkundige Vereeniging. This edition will include a small recap and some opinions from the organizers of this week as well as an interview with Jakob Damen, the Treasurer of the MV. I would like to express my gratitude for Bill Rossen, not only for giving us the opportunity to interview him, but for writing a clarification article regarding the name change of the section Petroleum engineering

Claire Mulder's bachelor thesis and the master thesis of Pieter Bosman have been included in this edition to display the achievements of our association members. The editorial team would like to thank them both for sending their theses summaries.

I would like to thank, once again, Koen Weber for his quarterly puzzle. Just as last edition, we have included the names of all those who submitted their solutions to the puzzle. Don't forget to complete the puzzle as soon as possible and to send your answers to our email. If you are the first to send the correct answers, you can claim a free crate of beer at the MV. I would also like to add that you are very welcome to send input to our email, which you can find in the last page of the magazine, as we always want to improve this beloved miner magazine.

On behalf of the editorial team, we wish and hope that all this wonderful community, and their relatives, are safe from any adversities. Keep safe, be strong and of course, Glück Auf.

Alonso Ocampo
President of the NRC



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WEBERPUZZLE

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Dear Readers,

While you are reading this, you are probably stuck at home just like I am while writing this update on the current state of affairs within “De Mijnbouwkundige Vereeniging”. Hoping that you are all in good health, this edition of the Natural Resource Magazine might come as a nice distraction.

Unfortunately, we had to cancel all of our upcoming events and we are uncertain when we will be able to start our daily routines again. Luckily, the eleventh Halfuistrum was a great success and a nice conclusion to the first half of this amazing year before this situation started. Thank you all for your contributions and attendance. In the meantime, we are busy with virtual meetings and figuring out how we are going to make the best of the last part of the year. It is also a great opportunity to lose our “bestuurskilo’s” now that we have the time to go outside in the early spring.

Of course, we are also concerned about how you, our members are doing now that we do not get to see you in or outside the MV room and our beloved café. Do not hesitate to contact us regarding any questions, updates on how you are doing or nice initiatives we could organize via Skype or something along those lines. I would also like to take this opportunity to urge you to reach out to and to check up on each other because some of us may need some positive social contact.

Lastly, I would like to thank all the contributors and the Natural Resource Committee for their great effort and to conclude with a warm and sincere Glück Auf!

Daniël Ernste
President of “De Mijnbouwkundige Vereeniging”

THE FUTURE.
YOURS TO MAKE.



“I want to be
able to look
back

And say
I played
my part”

Ryan
Engineer at Shell



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How earthquakes deform gravity

February 21, 2020

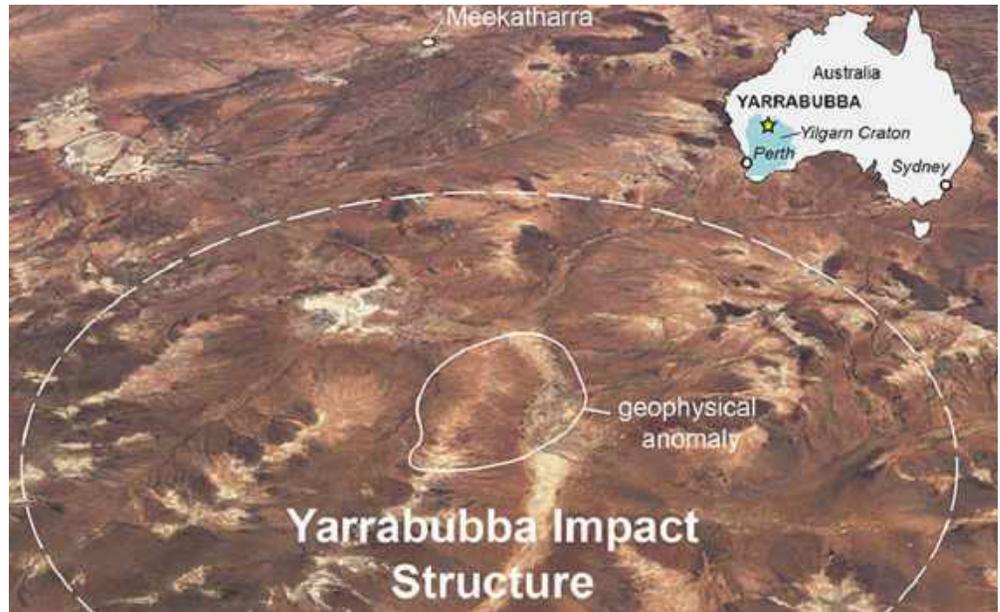
Researchers have developed an algorithm that for the first time can describe a gravitational signal caused by earthquakes with high accuracy. Tests with data from the 2011 earthquake near Fukushima show that the procedure could help to improve earthquake early warning systems in the future.

Earthquakes also send out signals that propagate at the speed of light (300,000 kilometers per second) and can be recorded long before the relatively slow seismic waves (about 8 kilometers per second). However, the signals that travel at the speed of light are not lightning bolts, but sudden changes in gravity caused by a shift in the earth's internal mass. Only recently, these so-called PEGS signals (PEGS = Prompt elasto-gravity signals) were detected by seismic measurements. With the help of these signals, it might be possible to detect an earthquake very early before the arrival of the destructive earthquake or tsunami waves.

However, the gravitational effect of this phenomenon is very small. It amounts to less than one billionth of the earth's gravity. Therefore, PEGS signals could only be recorded for the strongest earthquakes. In addition, the process of their generation is complex: they are not only generated directly at the source of the earthquake, but also continuously as the earthquake waves propagate through the earth's interior.

Until now, there has been no direct and exact method to reliably simulate the generation of PEGS signals in the computer. The algorithm now proposed by the GFZ researchers around Rongjiang Wang can calculate PEGS signals with high accuracy and without much effort for the first time.

<https://www.sciencedaily.com/releases/2020/02/200221102118.htm>



Scientists just discovered that an asteroid may have ended 'Snowball Earth' 2.2 billion years ago

January 21, 2020

Some 2.2 billion years ago, an asteroid slammed into the Earth, leaving behind a massive, 43-mile-wide crater in what's now Western Australia, scientists announced Tuesday. It's the world's oldest known impact site, the new study said, one that also may have changed Earth's climate: It occurred at a time that coincided with Earth's recovery from an ice age known as "Snowball Earth," where most of Earth's surface was covered with ice sheets up to 3 miles thick, according to a statement from Imperial College in London. The impact left behind a scar on the land that's known as the Yarrabubba impact crater.

<https://www.sciencedaily.com/releases/2019/12/191219162350.htm>



Volcanic eruption sparked a weeklong thunderstorm, and scientists want to know why

February 28, 2020

In December 2018, after months of sputtering, the Anak Krakatau volcano in Indonesia collapsed. Its southwestern flank slid into the sea, shoving a wall of water into the neighboring islands of Sumatra and Java. The catastrophic event and resulting tsunami killed more than 430 people and injured thousands more. The collapse was only the start of Anak Krakatau's fiery fit. The volcano continued to billow a gaseous plume miles into the sky, feeding a rare six-day thunderstorm that sparked with lightning. The event offered scientists an incredibly detailed look at how some eruptions can affect local weather in remarkable ways. As described in a new study in *Scientific Reports*, this intense volcanic storm was supercharged by vaporized seawater that chilled to ice in the rising plume, unleashing more than 100,000 flashes of lightning.

<https://www.nationalgeographic.com/science/2020/02/volcanic-eruption-sparks-week-long-thunderstorm/>



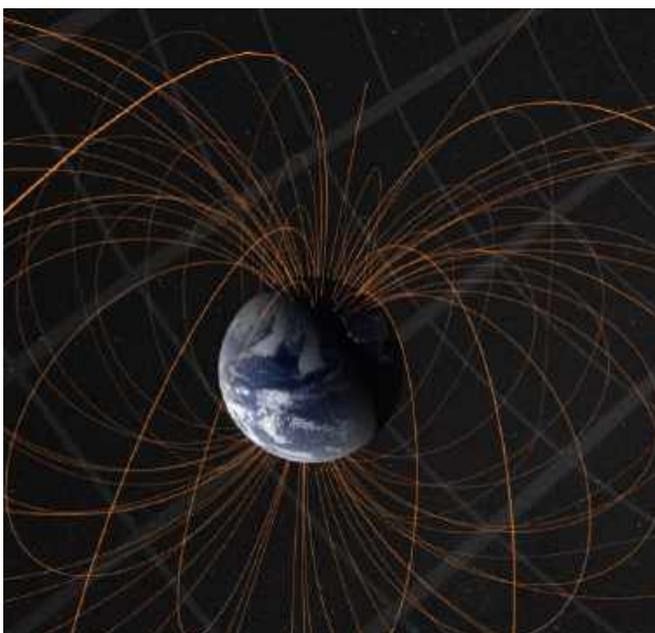
The Mediterranean nearly dried up. A cataclysmic flood revived it.

March 6, 2020

THE SERENE TURQUOISE waters of the Mediterranean Sea hide a sharp-tasting secret: a layer of salt up to two miles thick, lurking deep underneath the basin. The ghostly white minerals are one of the few traces of an ancient Mediterranean Sea that vanished millions of years ago. Some scientists believe that the entire sea evaporated for a time, desiccated like the Sahara to the south.

Even after decades of study, the details surrounding the sea's vanishing act and the torrents of water that refilled the basin remain an enduring mystery. The refilling of the Mediterranean about five million years ago may have been the biggest flood in our planet's history. By one estimate, the cascade of water that filled the cavernous basin was about 500 times larger than the flow of the Amazon River.

<https://www.nationalgeographic.com/science/2020/03/mediterranean-nearly-dried-up-cataclysmic-flood-revived-it/>



Covid-19: How the coronavirus pandemic is hurting the mining industry

March 17, 2020

The World Health Organisation has declared the Covid-19 coronavirus outbreak a pandemic. With over 180,000 confirmed cases at the time of writing, even the most optimistic analysts fear we are heading towards a global recession. Several mining companies have been affected by Covid-19 outbreaks, and global restrictions to encourage social distancing have meant some mining projects have either slowed or shuttered. Here we explain some of the major ways the coronavirus crisis has impacted the global mining industry.

Restrictions put in place by governments to contain or delay the spread of Covid-19 have placed difficulties on mining companies operating in affected countries. In Italy, the worst affected nation outside of China, the national lockdown currently in effect has resulted in Alta Zinc closing down production at its flagship project in northern Italy. Italy's current lockdown is scheduled to continue until 3 April, but Italian authorities acknowledge that the lockdown could be extended if necessary.

<https://www.mining-technology.com/features/how-covid-19-is-hurting-mining/>

An ancient magma ocean may have once driven Earth's magnetic field.

February 27, 2020

Billions of years ago, Earth's magnetic field may have gotten a jump-start from a turbulent magma ocean swirling around the planet's core.

Our planet has generated its own magnetism for almost its entire history (SN: 1/28/19). But it's never been clear how Earth created this magnetic field during the planet's Archean Eon – an early geologic period roughly 2.5 billion to 4 billion years ago. Now, computer simulations suggest that a deep layer of molten rock-forming minerals known as silicates might have been the culprit.

"There's a few billion years of Earth's history where it's difficult to explain what was driving the magnetic field," says Joseph O'Rourke, a planetary scientist at Arizona State University in Tempe who was not involved with this study. This new result, he says, is a "vital piece of the puzzle."

<https://www.sciencenews.org/article/ancient-magma-ocean-may-have-once-driven-earth-magnetic-field>



Bachelor Trip

February 3 - February 7, 2020

First and Second year students attended the Bachelor trip during the break to relax with fellow miners and go to multiple companies and locations throughout the week. This trip included several visits to for instance TATA steel, NAM Schoonebeek and Fugro, which did not mean that there wasn't time for some well earned beers in bars scattered around The Netherlands and Germany.



Darts Tournament

March 10, 2020

You don't have to be a beer drinker to play darts, or have a huge beer belly, but it definitely helps. The SpoCo hosted a darting tournament in the Dutch 'Ally Pally'; Café Friends. The MV darters challenged against 'Bedrijfskundig Genootschap, the study association of Technical Business Studies. During that evening miners unleashed their inner Michael van Gerwen or Phil Taylor and landed 180's one after another. Of course, the MV quickly sealed the deal and could celebrate over Planet Funk's hit song 'Chase the sun'. Congratulations to James for winning with the highest overall individual score, and James, Jan-Willem, Friso, Tim and Wesley with the highest team score!



Python Workshop

March 9, 2020

In this fast paced world, being able to unstrangle a coding language is essential for any job. TU Delft has decided to change from Matlab to Python, meaning that old students have to update their existing skills and new students have to learn this language from scratch. These pizza and coding evenings were organised to help miners grasping the basics of python. With rattling keyboards and sizzling desktops or laptops, miners started to constrict large piles of code into smaller ones, devour bugs and code Nokia 3310's famous game. After this evening most students could crown themselves 'King Python'.







INTRODUCING TO YOU, THE

TREASURER

OF THE 128TH BOARD

Meet Jakob Damen, the 128th CFO of the Mijnbouwkundige Vereniging. Don't mind the 1.5 meters distance he keeps from you, it's not because he's afraid of catching a virus from you, he simply prefers it that way. This behaviour is what makes him so good with money. He can spend hours upon hours working in Exact, making sure each and everyone of you pays your 12 euros and that the money is used well. Sadly he can't be at the MV anymore at least until April 28th, but you can always hit him up via skype!
Username: dolla_billz_yall

What do you do in your free time?

I like to read, I try to finish one book every two weeks, but I also read like three books at the same time, one story book, one scientific book and one philosophy book. Besides that I enjoy going to the gym and to go for a run from time to time.

What's the most fun thing you've done with the MV?

I think the extended Noorden evening during the lustrum week when I was part of the NoCo, it was really amazing, the preparing was fun and the party as well, we made a 'techno bunker' of Het Noorden. One nice memory about that night is that I fell asleep on the kegs in the basement, I slept for like two hours, then got up and went back to the party.

Did you consider any other studies before choosing AES?

Before I started here I studied astrophysics in Utrecht, but I quit after two months. Then I wanted to go to Delft and I liked geology, so it seemed like a proper choice, but to be honest I don't really like it. First I'm going to finish my bachelor here and then for my master I want to do something else, namely econometrics in Rotterdam. The mathematical aspect is something that is really appealing to me, but I'm also thinking of maybe doing applied mathematics. However my interests lay in the financial sectors, so econometrics then seems to fit better.

What do you like about being treasurer?

You can have a lots of great ideas, but if there isn't any money, that poses a problem, so the treasurer often has the last say in things. (Jakob continued to say that our magazines are over budget so we threatened to cut his interview out. He did not touch the subject again)

Which event of the half lustrum did you like the most?

The Noorden extended evening was my favourite again. I think it was the best party we've had the last two to three years, normally people get lazy in dressing up with a costume, but during the Noorden extended evening everybody puts in their effort which was nice to see. Another great thing about the Noorden extended evening was that I got to wear my princess dress.

What would each of your fellow board member do if they won a lottery?

Guus will for sure buy Het Noorden and give out unlimited free beer for everyone. I think Claire would probably purchase a private jet, so she doesn't have to fly economy class. Daniël would buy tons and tons of hair conditioner for his curls and Frederieke will find and buy all the gluten and then destroy them. The thing I would buy is probably a big mansion in the forest with a private gym and a pool, the whole picture.

What would you add to the MV room if you had an unlimited budget?

A lot of roombas for sure, so the MV room stays clean, some really comfortable couches and how about a private chef for the lunch? Then we could get some nice tosti's. Of course we would also need the most epic coffee machine ever so all the member have the best coffee. I really enjoy drinking good coffee, I also have my own little coffee machine on my desk, because I don't like the coffee from the machines at the faculty. My fellow board members found it a bit stupid but



then we lost the coffee card for a while and they all drank the coffee from my little machine. Afterwards they didn't want to go back to the generic coffee.

Did you know the rest of the board well before you started this year?

Actually I did, Daniel and I became friends in the first year, I did some projects together with Claire and in my third year Frederieke and I were both in the External Committee and I know Guus from drinking. Once my NoCo had to tap at PSOR and none of my fellow NoCo's were able to be there, so I called Guus and asked if he wanted to join and he did. Since it's not our cafe we were a bit lazy with the service and people were getting impatient for their beers but instead of helping them we decided to do a polonaise to a bottle of Ketel 1 at the other side of the cafe, take a shot and get back while people were still waiting. It was a lot of fun, that's how I know Guus.

What is the nicest bottle you got for tapping at an event when you were NoCo?

To be honest I can't remember the best but I do recall the worst, there was a new professor at the faculty and it is tradition that they give a borrel in Het Noorden and the bottle I got from tapping was a typical Finnish drink, Akvavit and it tasted like old cartonboard. A lot of Finnish people really like it but I took one shot and almost puked, it was so gross. I gave the bottle to my parents in the end, so it's now in their liquor storage, but just for decoration really.

We heard some rumors you are going to brew some beer of your own at the basement of Het Noorden.

Yes we had the plan to make our own beer brewery in the basement, it will be called 'Barbara's Delight'. During the holiday between the second and third quarter it was too big of a mess in the basement to make a start, but maybe later this year.

What's your favorite beer?

Definitely 'Barbara's Delight', even if it tastes like shit. Besides that I think La Trappe Tripel and Leffe Blond are really great beers.

Did your parents give you any advice before you started managing big money?

I just told them I was going to be board this year and they responded with 'Oh so you're going to take even more time to finish your study?'

What came first the Glück Auf or the MV?

Probably the Glück Auf, because at first everybody was saying 'Glück auf' and everyone who said that was a 'mooie pik', so all those 'mooie pikken' came together and created the MV.

-Melissa jumps in

The MV was first, they went to Germany at some point and brought the use of 'Glück auf' with them to Delft. Students back then went to work in mines, but there weren't enough in the Netherlands so some of the students went to Germany and they heard 'Glück auf' quite a lot there. That's what Weber told us during the yearbook ceremony during the Halfflustrum week.

How do you feel about walking around the campus in your suit?

Some people say that I am overdressed, but I think all you guys are just underdressed. At the old faculty everyone would wear their tie and jacket, we were the last faculty in The Netherlands that stopped making it mandatory for students to wear their ties.

What's your favorite committee in the whole MV?

The external committee sort of became my baby, because I was in the first external committee and at the moment I'm making plans on how to keep this committee in the MV and how to do even better the coming years. It's a very useful committee and quite important one too, it makes sure there is more money for the MV which I find very interesting, especially as being treasurer. ^[1]

Any scoops?

I have a sneak preview; I had a meeting with the dean about a graduation wall. In the architecture building you get a see through plastic with your name and the year you graduated and you can put it on the wall. Aerospace has one with signatures. So now we want to make one with our faculty and combine it with civil engineering for all the upcoming engineers. So after the meeting with the dean, if he likes the idea, it is probably going to happen. Where it is going to happen is still top secret.

Fun facts?

I can tell you a really strange thing about me. I've been doing this for 20 years now, since I was really young. When I'm starting to sleep, I wiggle my head from left to right, I don't know why, but that's how I fall asleep. If I have a friend over, I can just not do it and sleep like normal people do I guess, but when I'm on my own it's really calming. Another fact about me; Last year I listened to Spotify for a total of 70 days, that's 20% of the whole year that I listened to music. I listen to a lot of hiphop, that's my main genre, I have like 40 hiphop posters in my room as well. I listen to jazz when I'm reading, cause then I don't like listening to lyrics. Then when I try to focus, I listen to lo-fi hiphop.

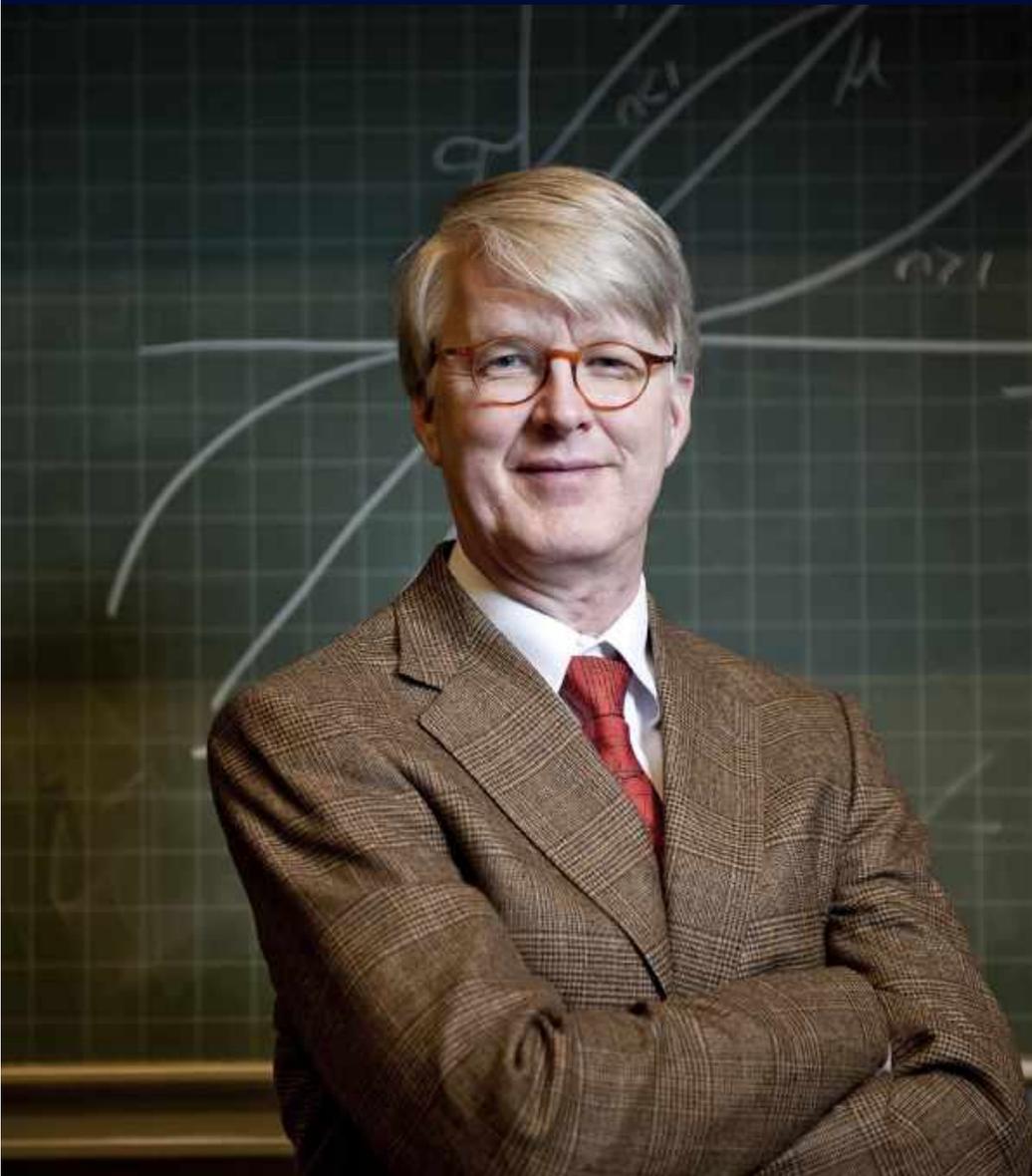


“ We have the plan to make our own beer brewery in the basement, the beer would be called 'Barbara's Delight'. ”

Glück Auf!



Meet Bill Rossen



Hello, I am Bill Rossen and I'm professor of Reservoir Engineering in the Petroleum Engineering section. I teach the undergraduate course in Physical Transport Phenomena, which concerns fluid flow, heat transfer and diffusion processes. It's a subject I've taught for over 30 years and I really love it because it's got so many different applications. I am involved in the bachelors field exploration project and play a small part in the Grand Challenges course. This last year, as part of the revision of the masters curriculum, I'm teaching a course on multiphase flow in porous rocks.

Are you doing any research at the moment?

For over 30 years, I've been involved in research on foam for enhanced oil recovery. My main area of research is all about the complicated physics and geometry of bubbles trying to minimize their surface area and trying to translate that behaviour into the extremely complicated geometry of the pore space of rocks. Figuring out how to describe and use these processes is completely fascinating. Besides that, I'm into modelling of flow in fractured reservoirs. My focus falls somewhere between a focus on experiments and on big, complicated computer models. I'm not very good at creating large computer programmes. Instead, I tend to look for simplified ways of representing what we see. However, with these simple, perhaps incomplete, models, you can obtain handy insights of the whole picture.

How does your personality fit your way of teaching?

My approach is to transmit information, teach something, explore all the different applications and pose questions based on the things we discussed. From my own experience, I need to be writing things down to be paying attention. If I were in a meeting, I would probably have a pad of paper out and be taking notes just to help focus my thoughts. I'm a big believer in writing things down, as a way to reinforce learning, rather than just looking at some Power Point slides. Another aspect has affected my way of teaching is that I was taught in a very different time, when writing things in paper was the only possible way of taking notes. At the end of each term I would have a stack of notes which I would condense into a summary of a few pages for each course. Each summary would be an index to make it easier to find the details in the notes or the book, in preparation for the exam. As part of my PhD studies, we had a qualifying exam that could, in principle, ask you about anything you'd ever studied in college. I procrastinated, something that I really don't recommend for students, and realized that I had only a month left to study. But I just went back to this folder and was able to retrieve all this information because everything was organized by course. I had perhaps fifteen of these little three-page summaries, and, with one day per subject, I was able to review what I had learnt in all of the major subjects I'd studied at school. That is exactly what I try to do in the Physical Transport Phenomena class, I try to make concise notes for my students so that they can look it up easily years in the future. However, this technique may be growing a bit old, given that most students do not store papers anymore.

We read that you are an associate editor of the Society of Petroleum Engineers journal, can you tell us something about that?

Oops. My personal web page is way out of date at the moment. I hope

to update it soon. I used to be an Associate Editor of the Society of Petroleum Engineers Journal, but I realized I was often falling behind on my assignments and it would be more honest to drop that. I still do editing for scientific papers. I am sent papers by the Associate Editor to peer review. I would say I enjoy writing articles myself and also like reading my students' scientific work, which is a surprise to me, actually. When I was in college and in graduate school, writing was very difficult and slow until I learned how to brainstorm and to organize my thoughts. When I was 11 years old, I was planning to become a lawyer, as there were some television shows with very dashing

their work and when I looked at them, I didn't think I could do it. Because of this, I did not even look for a university job when I finished my PhD: I started working for a company. I worked in research at Chevron Corporation for 7 years and then realized that I actually wanted to do university teaching and by then, fortunately, I was able to publish a few papers, meaning that it was easier to apply for a position.

How did you introduce geothermal applications in the Physical Transport Phenomena course?

I've been trying to connect the course with geothermal energy for a while. There are several problems

to represent a geological formation is that pores are just tiny tubes. In another exercise I would ask "if I injected hot water into this tube of 100 μm diameter, how far would the water flow before it comes to the temperature of the rock?" It's a very striking result: it travels 7/10 of a micrometer over the course of two hundredths of a second before it's at the temperature of the rock. That's faster than I can blink. The conclusion is that the fluid and the rock that are in contact with each other are instantaneously at equilibrium. But if you have one layer with cold water flowing through it and a hot layer that's impermeable up above then the process is a lot slower, meaning

“
My approach is to transmit information, teach something, explore all the different applications and pose questions based on the things we discussed.
”



and heroic lawyers defending the unjustly charged. I clearly didn't end up as a lawyer, but I have realized that in some sense, I fulfil some of those same desires through scientific writing. As a lawyer, you have to pick your way between narrow arguments and figure out what is the evidence for this, and so forth. We do the same in our scientific writing: we've done this experiment, does it absolutely prove what we want? is it in agreement or disagreement with what we want? You collect all the evidence and make the argument that is most justified.

Why did you start teaching?

I really love it. From the start of graduate school it was my goal to get a university position to teach. However, my advisors in graduate school were extremely focused on

I made, about six or eight, and they have been discussed in class or been exam questions. For example, one problem that I just started doing in lecture last year is a question that states "If I'm injecting cold water into one well and producing hot water from the other well, how long does it take the cold water to arrive?" At a first glance, it may not be obvious that the cold itself arrives much later than the water. If you'd track the water molecules, they would show up at a particular time, while the cold front is moving at about a third of that velocity.

The reason is that as the water flows into the rock, the rock is still warm and heats up the fluid. As a result, the fluid is not just moving, it's picking up the heat from the formation.

When we learn about heat transfer through tubes, the simplest way

that we have to apply unsteady conduction models.

The first time I heard about this idea of sending water two kilometres up this well and counting on it still being hot when it gets to the top, I thought "how could that be? They must really insulate the well!" It turns out that plastic pipes are pretty good insulators on their own. Let's say for the first 24 hours you're heating up the near-wellbore region and you are losing your heat but after that point, as the heat moves radially outward, the whole process is slowing down so much that you're hardly losing any heat a week later. Phil Vardon works on heat storage, meaning that you pump hot water to the ground in summer and then pump out cold water in winter to recover this heat. That requires another technique we learn in class called superposition.



Bachelor trip



By T. Graafland:

During the 2020 bachelor trip, we visited a lot of companies, such as Fugro, the European Space Agency (ESA), NAM Schoonebeek, the Konrad mine in Salzgitter and TATA Steel. At all the companies we got a tour through the parts of the building that were of interest to us and after, the program was different everywhere we went. With Fugro, we discussed a case study in groups and got to do some work ourselves, NAM Schoonebeek brought us to an onsite Dutch oil pumping station (we could see the German pumping stations from across the creek) and ESA gave us an inside look on all the equipment used in space and the role Geoscientists can play within their company.

My personal favorites were TATA Steel and the Konrad mine. Even though we were all quite tired during the TATA Steel trip (as it was the last day), this was my second favorite trip. With our touring bus, we got a tour through a large part of the terrain. Also, the touring guide brought us to two halls in which the steel was processed, which was very nice to see in person. Unfortunately, one hall had some issues, so we had to skip that one. However, that was compensated by a longer tour

in the bus. Even though all trips were informative and fun, my favorite is the trip to the Konrad mine in Salzgitter, Germany. Here, with thanks to the Golden Honorary Member of the MV, Hans de Ruiter, we got a tour through this mine. It used to be an Iron-ore mine, but is now being reorganized to turn it into a nuclear waste storage. After we all got dressed for the mine (wearing overalls, helmets, goggles, and even strange underwear), a truck brought us down to 1200 meters. On the way, we stopped several times to look at unchanged parts of the mine, parts in progress and parts that were almost finished. It was very informative thanks to our guide and nice to see the mine with your own eyes.

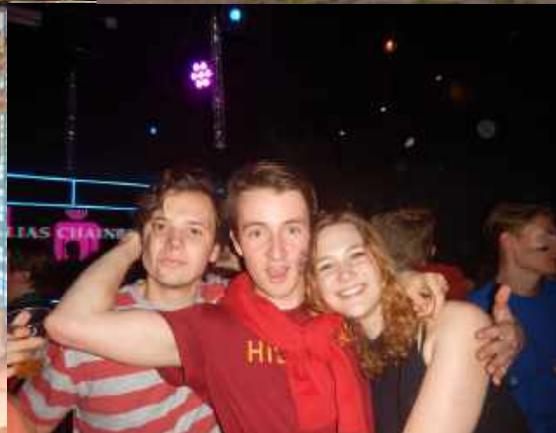


By A. Gatti:

Board members responsible of organizing the full trip, Claire Mulder and Guus Hoogewerf made sure that we would not get bored when not visiting a company. And they delivered with great activities that served as a good distraction from our vivid memories of long study days and exams sessions. Despite the cold temperatures and strong winds of Dutch Februaries, the first night after dinner at the hostel we decided to walk to the beach, only a couple of kilometers away. Guus surprised us by lighting up some fireworks and some of the boys even jumped in the water! The next day we had dinner at IKEA on our way, a great idea indeed! Then

after our visit at ESA it was time for the secret activity of the week, which wasn't really a secret to any of us. So we visited the almost deserted zoo at Amersfoort. Similarly noteworthy was our afternoon at a water park in Germany where they had water slides! That evening we, despite barely getting checked-in at the hostel, had some nice beer in a questionable Irish pub in Braunschweig, Germany. Witnessing the karaoke at that pub was an exceptional experience.

Then for our last night, in Haarlem, we continued the long standing MV tradition of being besotted.



It took mining to build the world we have today—and it will take mining to build the world of the future. But mining companies want to do more than just provide the raw materials on which the world depends. Together we have an opportunity to improve the quality of life and build a better world for generations to come. Every piece of Cat equipment is designed to do better and be better. And we're committed to helping every Caterpillar customer better use the products we provide. Because the better we mine, the better the world can be.

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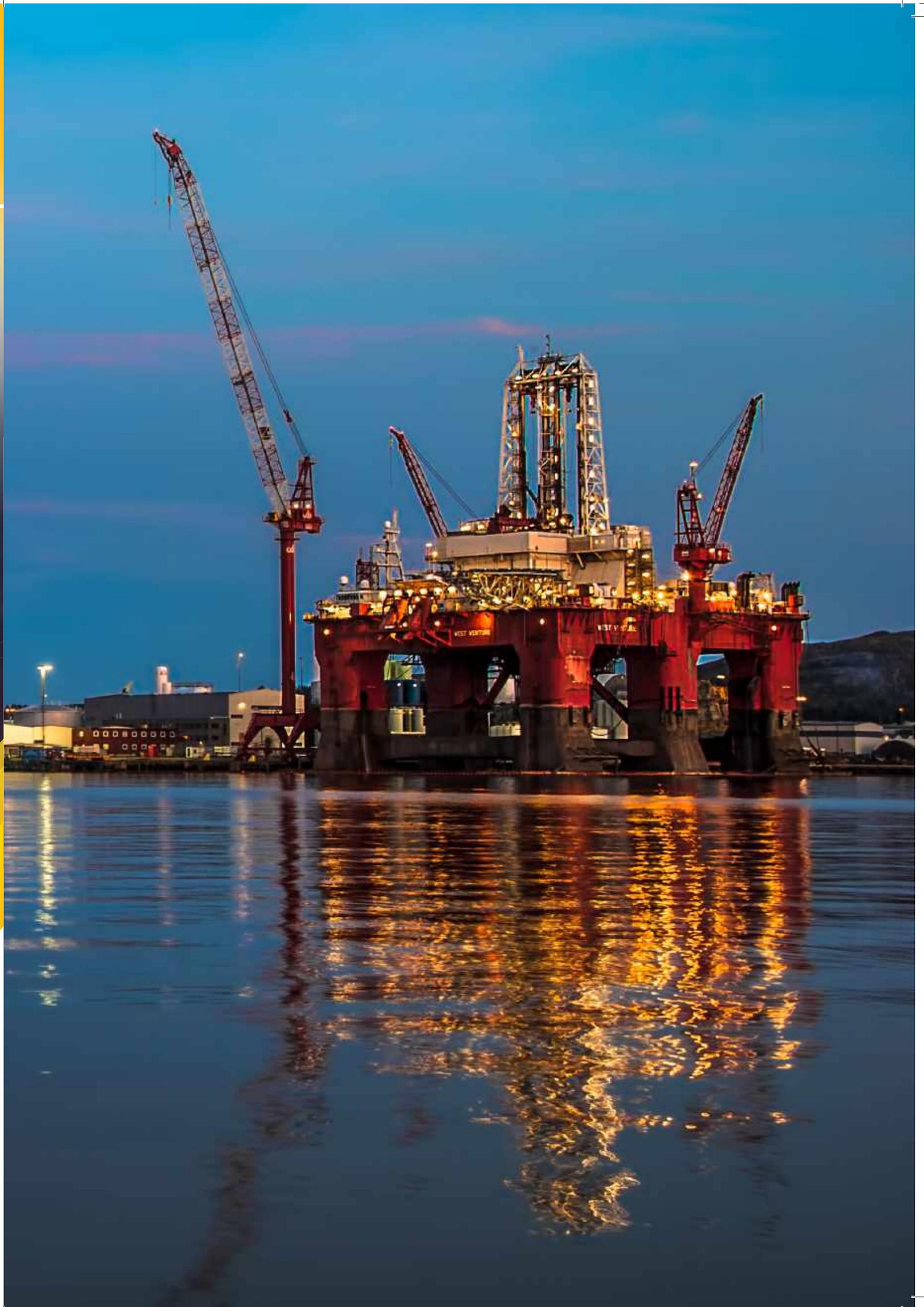
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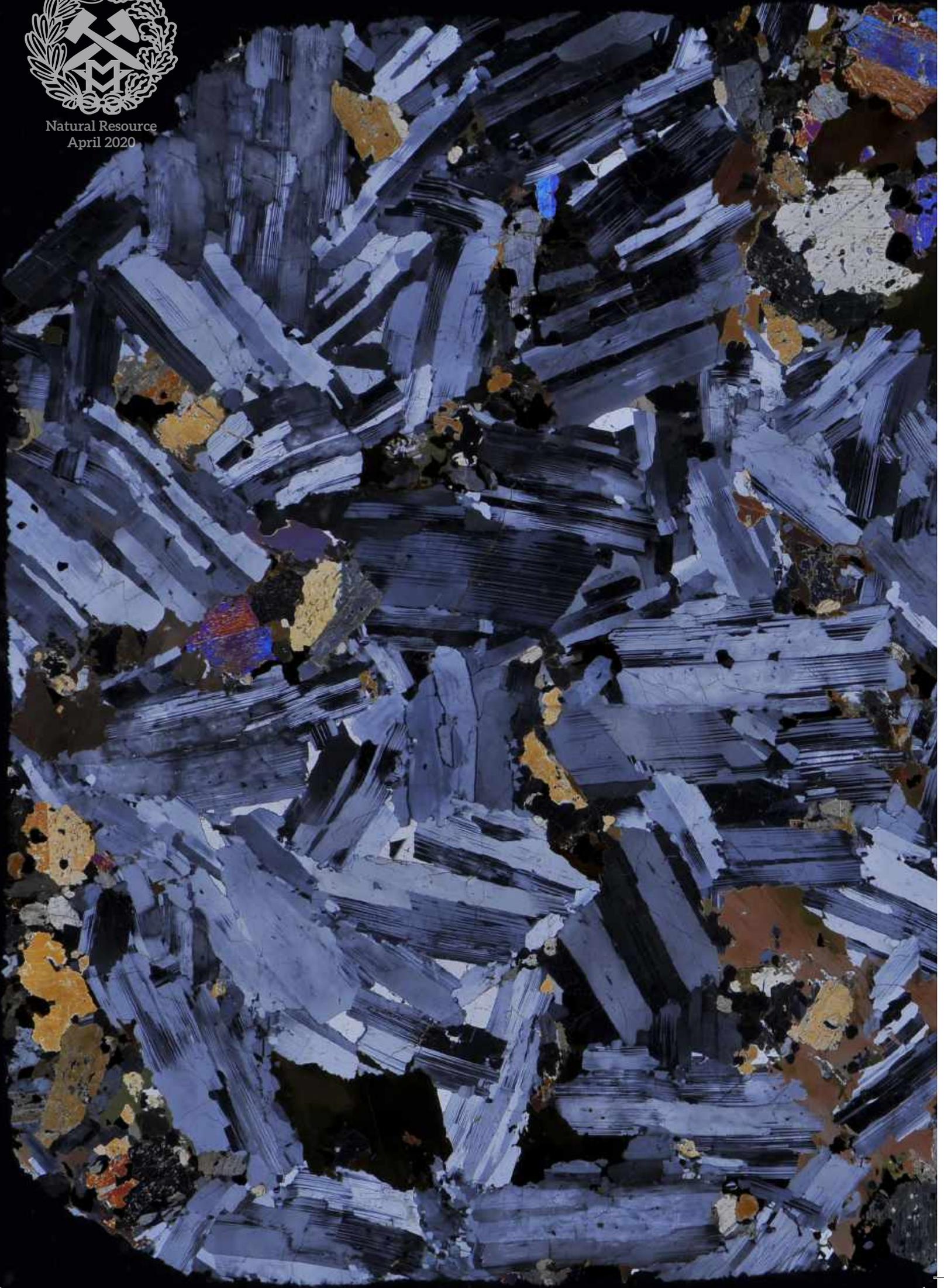
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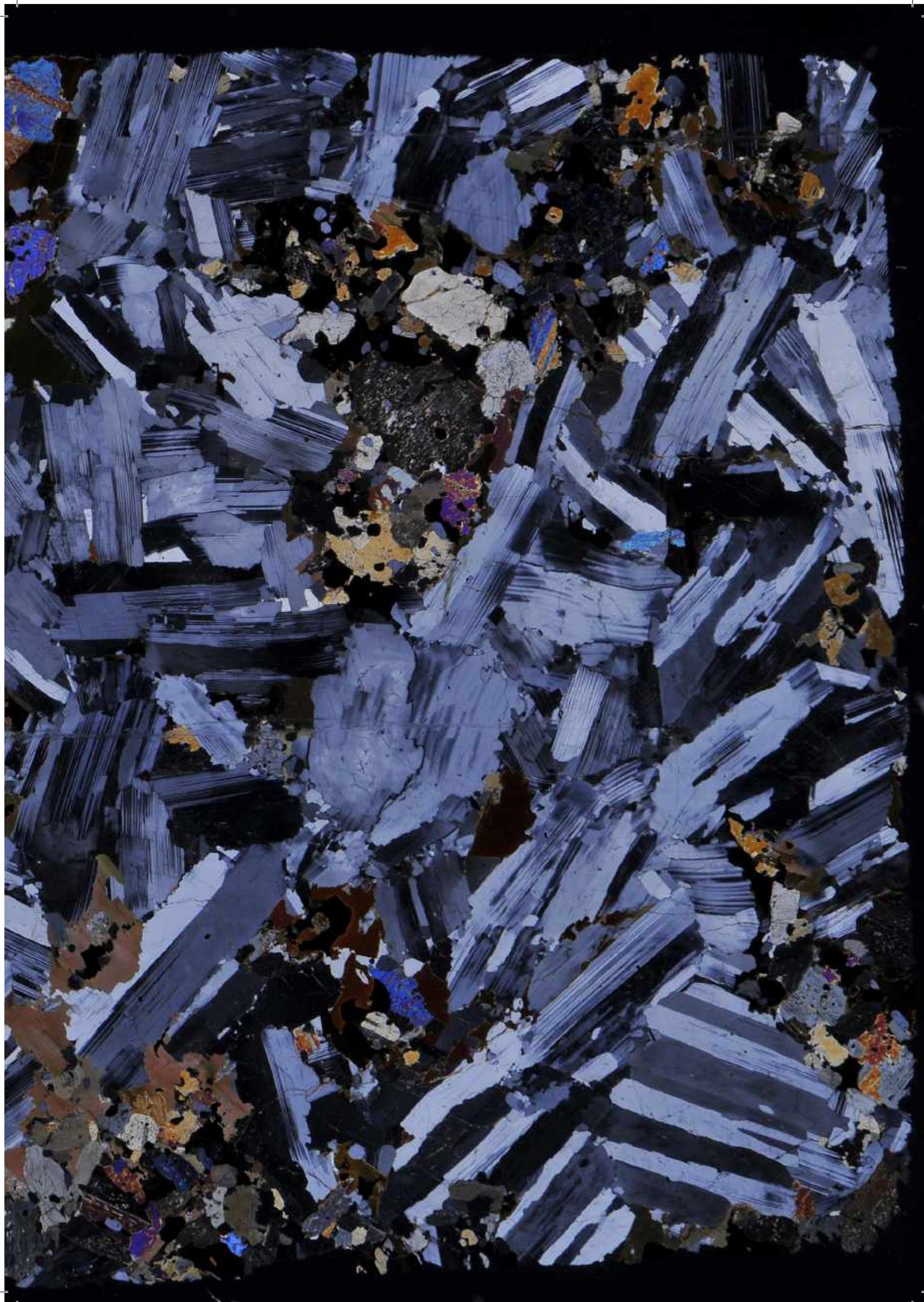






Natural Resource
April 2020







Natural Resource
April 2020

1892  2020



Fuel the Future

— 11th Halflustrum —

STORIES AND IMPRESSIONS OF THE 11TH HALFLUSTRUM

Dear miners,

On behalf of the Haluco, I would like to thank everyone who attended and contributed to the 11th Halflustrum.

We have now come full circle. About a year ago, Thijs reached out to our first sponsors as we started the planning of the 127.5th anniversary of the Mijnbouwkundige Vereeniging and today Rens is finishing up the last parts of the bookkeeping.

And what an amazing celebration it turned out to be! Make sure to check out all the photos on the MV site, to relive the festive opening and Marlee and the Symco's impressive symposium. Not to forget NoCo's fairy tale themed Extended Noorden Evening or the unforgettable Energize party made possible by Hein and the VNC.

For the Alumni, there are photos taken at the gezellige Alumni Dinner at the rooftop of the D.S.C. And last but not least, don't miss the photos from the wonderful Gala.

Once again, a huge thanks to all the people who were involved in organising and making this week possible, as well as everyone who participated and made the 11th Halflustrum so special!

Glück auf!
Julia Rudlang
President of the 11th Halflustrum Committee

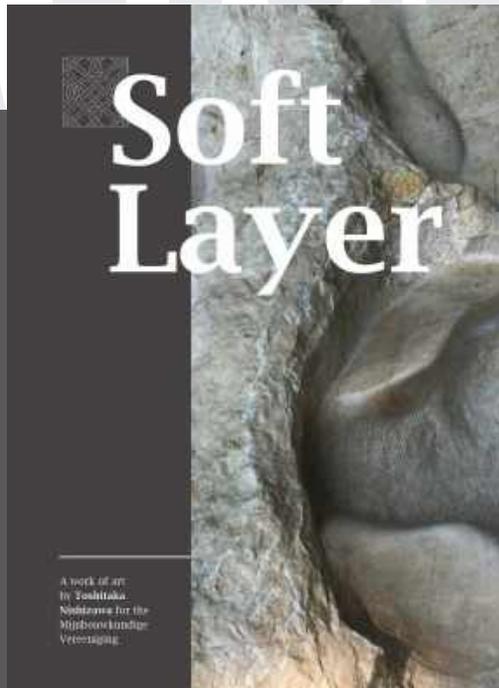


Monday

was the first day of the 11th Halflustrum. After an exciting period of preparing the festivities, the HaLuCo could finally open their week, accompanied by the revelation of the 80th yearbook and the MV work of Art 'Soft Layers' in front of the geoscience building.



▲ 80th Yearbook committee signing and handing out the most recent edition of the yearbook.



▲ Cover of the information booklet about the artwork. It can be found on the site of the Mijnbouwkundige Vereniging



▲ Revelation of the artwork in front of the GeoScience department in CEG



▲ MV-members and ISW-students celebrating the opening of the Halflustrum over a well-served dinner in the Verbeelding



▲ Official opening of the 11th Halflustrum by HaLuCo president Julia Maria Rudlang

Dear Miners,

In February 2020, the Mijnbouwkundige Vereniging was celebrating its 127.5th birthday. The Half-Lustrum took place from February 24 to February 29, 2020.

One of the festivities during this week was the Symposium. I had the great honour to be part of the organisation of this great day. Together with Marlee Spreij, Simon Dehout and Fien Louwerse we knew that we had quite a big challenge ahead.

The theme of the Half-Lustrum was: "Fuel the Future, Today's potential for a sustainable Tomorrow". With such a theme, the tone of the Symposium was already set. Of course, it had to be a formal day, but above all it should be an inspiring and interesting occasion.

And so, the adventure began already in June of 2019. Marlee was chosen to be president and Fien, Simon and I were all secretary of the Symposium. In the beginning there was already a great click within the group. We all had amazing ideas and the "energy" in the group was already "fuelled". Sometimes we came up with crazy ideas such as asking the CEO of ING, Ralph Hamers as a speaker, Arjen Lubach as moderator or even asking the Minister of Economic Affairs and Climate Policy, Eric Wiebes. We were so ambitious, and we were thinking as great as we could because we wanted to make sure that we had a line-up of speakers where we could be proud of at the end of the day.

Due to the large amount of ideas and all the uncertainties, we asked the previous "Symco" board to have a night of bowling and drinks with us. We got really helpful tips and got into the right track. Above all, it was nice to have conversations with people who were in the same position 2.5 years ago.



▲ The space of Theater de Veste, was fully used as interesting talks were also given in the foyer.



▲ The SymCo, on the stage in the main hall of the theater, presenting their symposium. f.l.t.r. : Simon Dehout, Barry Versluis Fien Louwerse and Marlee Spreij

Our goal was to organize the day in such a way that it made sense to let one type of company speak after another. First let the companies that are involved in the production of energy, both fossil and sustainable speak, then the companies that help facilitate the extraction and then companies who supply the generated energy to the inhabitants of the Netherlands.

At the end of the day we organised a panel discussion to get some insights regarding the "fuel of the future".

What began as a stressful day with some lack of sleep, ended with relief, happy faces and beers. At night, we had an excellent dinner at restaurant van der Dussen in the beautiful historic centre of Delft with almost all the speakers and some of the CvA. Here, the day was evaluated and discussed and concluded that it was a perfect day with a perfect ending.

For everyone who is reading this, if you have the chance to be part of the organisation of such a day, I'll advise everyone to do it because you'll also "fuel your own future".

I would like to take this opportunity to thank all speakers, the moderator, CvA, Theater de Veste, the sponsors, the 125th Symco and everyone who was present during this day! I hope everyone did enjoy it as much as I did.

I'm proud of Fien, Marlee and Simon who did a great job.

Glück Auf

Barry Versluis

Tuesday was dedicated to the symposium. The Symco created an interesting and well organised day in de Veste. Barry Versluis, as a member of the Symco, wrote down his experiences regarding the symposium in the piece above.

Wednesday

started with excursion to various companies. The offices of Baker Hughes, Huisman and GATE Terminal all opened their doors to interested miners.

With their minds opened by the symposium on the previous day, miners were full of questions to ask their tour guides and office workers. Later that day it was time for the first of many parties during the week, 'Het Noorden' opened its doors to all willing to party; the legendary Extended Noorden Evening.



▲ Students enjoying a safe tour around the Huisman Innovation Tower.



▲ The 48th NoCo, who turned our favourite cafe into a fairytale. The classic fairytale of 'Lonneke and the 7 NoCo's



▲ Dressed up MV-members enjoyed a beer, good music and dancing during an enchanting evening in 'het Noorden'.

Thursday

was a so called 'resting day', but only during the day, as at 10 o'clock a big party started in a club in Rotterdam.

Dubbed 'Energize', the Open Party was organised by the VNC, who hired various famous hip-hop acts, next to some big DJ-duo's. An energetic evening followed, where party people danced till the dying seconds of the celebration.



Friday

the HaLuCo organised the Alumni dinner in the Roof terrace of Sociëteit 'Phoenix'. With dinner served, alumni could enjoy dinner and refresh stories from the time they were students.



- ▼ Students all found their way to the somewhat remote venue in Rotterdam, some even arrived with a 'watercab'.



- ▲ A fine capture of the atmosphere present during the special evening in 'het Koetshuis'.

Saturday

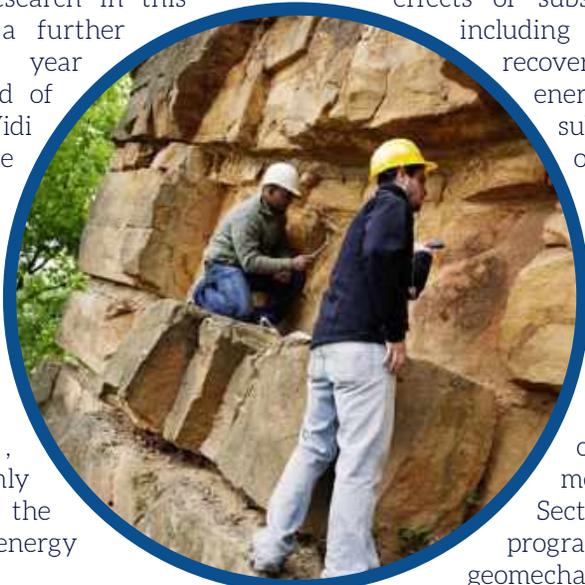
the final event of the 11th Halfustrum took place. A prom was organised in a venue in Rotterdam. Suited well, miners gathered with their dates in the inviting place and enjoyed themselves over a drink and fine music. A great ending to a fantastic week.

THE EVOLVING FOCUS AND NAME OF THE PETROLEUM ENGINEERING SECTION



By: W.R. (Bill) Rossen
 Section Head, Reservoir Engineering Section
 Department of Geoscience and Engineering

The broadening of our research focus began over 15 years ago with the major Dutch government CATO and CATO2 research programs on subsurface CO2 sequestration. Members of the PE Section collaborated with other scientists within the Department on this theme, which eventually led to the introduction of the 'Delft Subsurface Storage' theme last year. This initiative includes subsurface sequestration of CO2 and storage of methane and "green" hydrogen from periods of peak production for use during periods of excess demand. It provides a unique opportunity for PE section members to connect different geoscience and engineering disciplines within our department. Research in this field received a further stimulus last year with the award of a prestigious Vidi grant. The theme ranges from laboratory and numerical simulation studies to hydrogen dynamics in porous formations, which are highly relevant in the current energy transition.

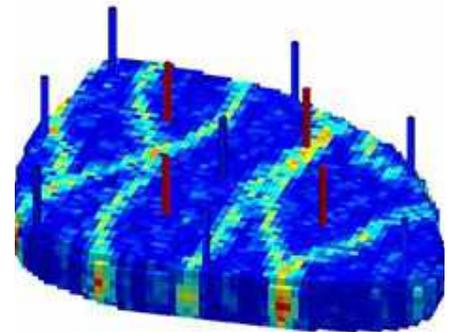


In 2007, with initiative and leadership from students and alumni of our Department, the Department initiated a major effort in geothermal energy, leading to the Delft Aardwarmte Project, or DAP. With alumni and administration support through DAP, this effort quickly extended to drilling a geothermal doublet for a local greenhouse. Plans are near final approval for drilling

a geothermal doublet on campus, which would supply heat for campus buildings. It will also serve as a major research facility for the geosciences. The overall project covers all aspects of the geothermal heat production, ranging from geological prospecting to geophysical monitoring to optimization of surface heat networks on campus. This geothermal research theme now includes staff throughout and outside the Department, and the growth of this theme led to the appointment of Maren Brehme as our new colleague in PE.

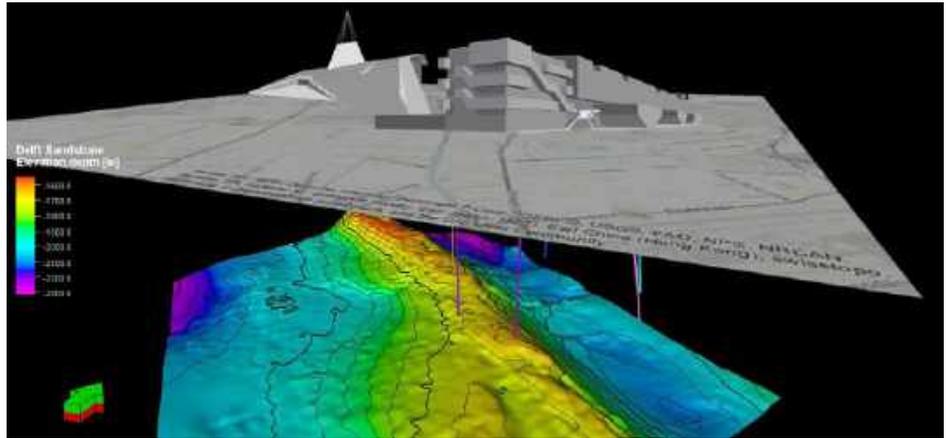
A third major interdisciplinary research theme in the Department focuses on monitoring and mitigating the surface effects of subsurface processes, including hydrocarbon recovery, geothermal energy, and subsurface storage of fluids. The Department was a major recipient of government research grants in the DeepNL program directed at this problem, three of which involve members of the PE Section. This research program investigates geomechanics and induced seismicity with laboratory experiments, modeling and simulation, and field-scale studies.

Complementary to these Department-wide, interdisciplinary research themes, the research within the PE Section continues in improving the efficiency of hydrocarbon recovery, a necessary and key element of energy demand during the period of transition to a



carbon-neutral economy. Improving efficiency also implies reducing the carbon footprint of the process of hydrocarbon recovery. One research effort focuses on minimizing the CO₂ footprint of hydrocarbon recovery as well as of “green” energy production. All this work builds on our proud history of excellence in petroleum engineering research and education. Staff of our Section continue to be active on a national and international level, for example in KNGMG, SPE and EAGE, but also in the International Society of Porous Media and the International Geothermal Association.

As someone coming from another university, I have long admired the integration of geosciences and engineering in the MSc curriculum of Petroleum Engineering and Geosciences at TU Delft. This degree of integration is absent in many PE programs internationally, where geosciences and engineering are often located in separate colleges on campus. Starting in fall 2019, the MSc track of Petroleum Engineering and Geosciences has been replaced by



Petroleum Engineering, Applied Geology and Applied Geophysics and Petrophysics. About half of those entering this program last September indicated that the broader focus of the program was a major reason they were attracted to the degree.

To reflect the broad range of applications of research and education in the Section, the PE Section is changing its name this spring to the Reservoir Engineering Section. This change reflects the incorporation of diverse applications of subsurface reservoirs as sources of hydrocarbons,

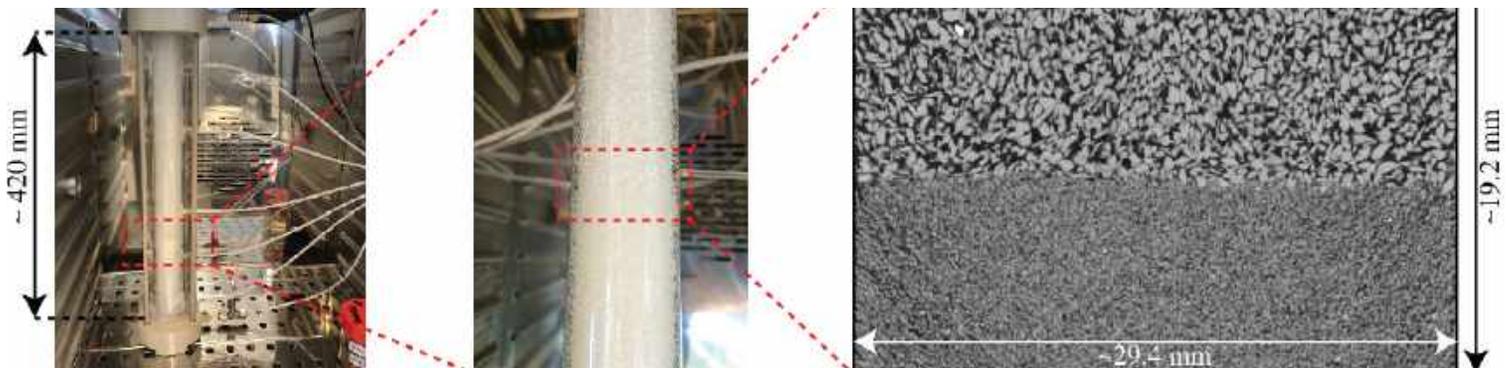


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the broader GeoEnergy Engineering (GEE) track to allow students to focus on a range of applications including, but not limited to, hydrocarbon recovery, geothermal engineering, and subsurface storage. In addition, the surface effects of subsurface processes and the transition to new energy sources receives more attention in the new GEE track. The program was designed by an interdisciplinary team of younger staff from the Sections involved:

heat and groundwater, as well as potential storage or sequestration locations for CO₂, hydrogen, or other fluids. The new GEE track is described on the Department web site <https://www.tudelft.nl/citg/over-faculteit/afdelingen/geoscience-engineering/>

The broadening of research themes is also described there; the transition in the name of the Section will be implemented on the web site this spring.





Bachelor Thesis: ERT and GPR as Potential Geophysical Tools for Detecting Clandestine Buried Forensic Evidence

By C. Mulder

Introduction

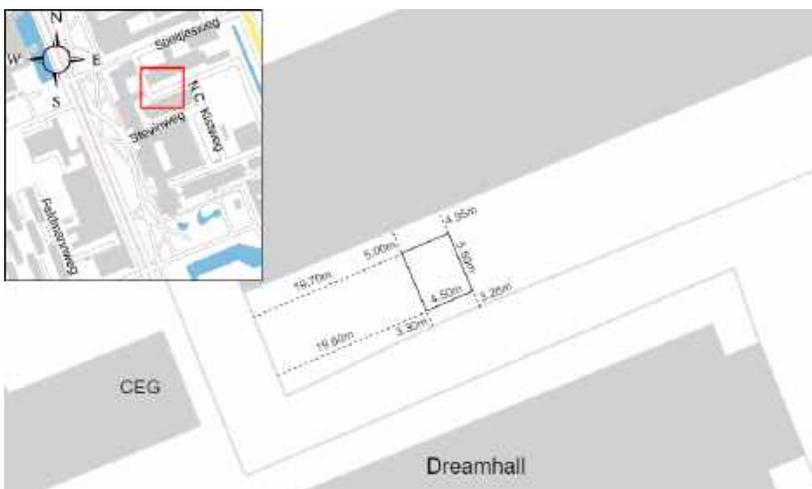
Since 2006 a total of 41 clandestine graves have been found in The Netherlands as a result of a homicide investigations (W.J.M. Groen, June 2019). Following a murder case where the body is missing, a team of specialized people from the police and the Netherlands Forensic Institute (NFI) go on a search for the missing body. This can take up to a few weeks, depending on the available information leading to the body location. Searches like these are vital for the conviction of a murderer, yet they can be inefficient and costly, and time is considered valuable in this context. The use of technology is therefore under development, more specifically geophysical technologies as tools for forensic investigations. Various geophysical methods have potential within forensics, on the grounds that they can detect shallow buried objects which are in this case forensic evidence such as weapons, and human bodies. Their non-invasive nature are beneficial, as it will not interfere with any murder evidence. This research project focuses on using electrical resistivity tomography (ERT) to detect buried plastic barrels used to simulate buried narcotics or weapons at the Technical University of Delft, and also human cadavers at a research facility in Amsterdam, The Netherlands. To analyze ERT as a forensic tool, models of the buried objects, along with models of the ground with and without a body were made and compared. For verification, images made with a ground penetrating radar (GPR) were used.

Research question:

How does ERT behave as a forensic tool to detect clandestine buried forensic evidence? To investigate this question, the following sub-question has been formulated: Can the location of buried plastic barrels be determined using 3D resistivity models obtained from 2D surveys?

Sites, Theory and Method

Two sites were used to perform the ERT and GPR data acquisition. The first site at the TU Delft campus was used to learn how each method worked and how to work efficiently. Together with Juan Chavez Olalla, a PhD Student at the TU Delft, we created a set-up and plan on how to work with the equipment properly and safely. The second site is the ARISTA facility. There are currently 3 human cadavers buried here, which are used to research the decay of human bodies in soil conditions found here in The Netherlands. At this facility, the methods used at the campus were applied after a few adjustments.



▲ Figure 1: The map showing the location at the TU Delft.



▲ Figure 2: The map in Amsterdam.

A grid of 10x10 electrodes was used and each data point was the result of 2 electrodes acting as the current input, and 2 electrodes measuring the potential difference. Configurations of 4 electrode arrays were used to acquire data sets and these sets were then processed further using a program called BERT [1]. This program uses forward modelling and an inversion scheme to invert the data and create a 3-dimensional model of the true resistivity of the ground. A detailed explanation of the theory behind BERT is written in the full report of this thesis, but the following is a brief description. The raw data implies the ground is homogeneous, and assigns an

average resistivity value to the modelled subsurface. The program then simulates an injected current/measured potential difference, based on the currents injected in real life. This produces a simulated data set, which is found using the following formula:

$$\nabla \cdot \left(\frac{\nabla V}{\rho} \right) = -\nabla \cdot j,$$

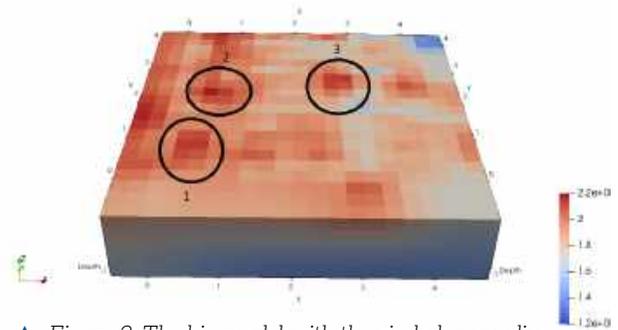
Where V = electrical potential [V], j = current density [A/m^2] and ρ = resistivity [Ωm] [2]. In the first data set all potential difference values are identical, and this is then compared to the actual measured data set during field work.

The values are compared through the method of least squares, which uses a function comparing the measured data to the simulated data. Through many iterations the data is simulated and compared and eventually a minimized function is found. This final data set is then used to create a 3D model of the true resistivity.

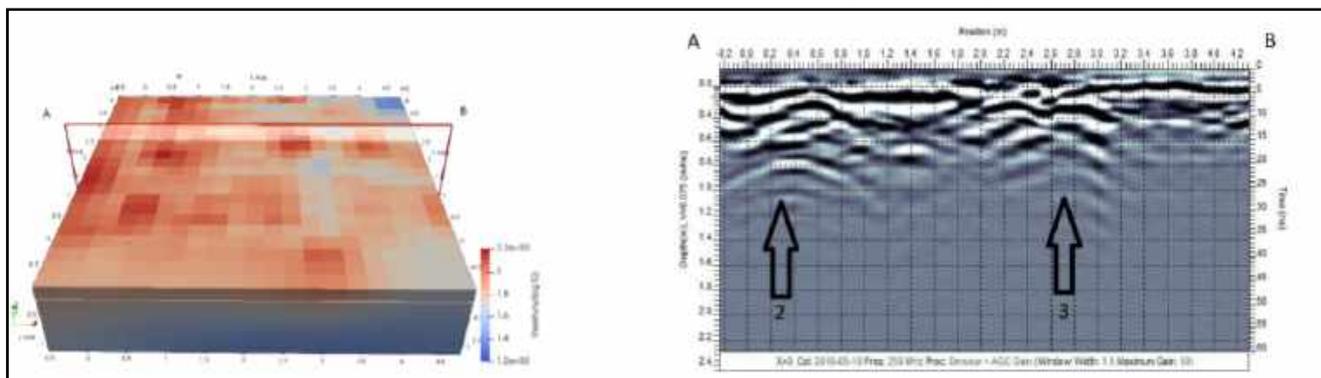
To compare the results of the ERT, a GPR was used. The GPR radargrams were made by pulling a GPR in straight lines over the ground. For a detailed report on the GPR data acquisition one can refer to Frederikke Hansen's bachelor thesis [3].

Results

The results of the ERT are shown in the figure on the right. Circles are drawn over the areas with high resistivity. A comparison with a GPR radargram is shown in figure 4 to show how these were compared to verify the results.



▲ Figure 3: The big model with the circled anomalies.



▲ Figure 4: The 3D plot compared to the radargram.

Discussion and Conclusion

The goal of this research project was to test the applicability of ERT as a geophysical tool in forensic investigations. The results at the TU Delft show clear anomalies with high resistances at three locations. Comparing the locations of these anomalies to the GPR radargrams, it can be seen that there are clear reflections here which indicate something in the ground with different properties than the soil. Overall, the potential of ERT as a tool to locate object buried in the subsurface remains, and research within this field should be continued and extended to establish how these tools can advance forensic investigations. Sadly the ERT instrument gave us faulty data from the ARISTA facility which meant we could not make any models here. The results from the TU Delft test site do however confirm the potential of the ERT.

References

- [1] Gunther, T. Rucker, C. (2011). Boundless electrical resistivity tomography bert 2 - the user tutorial
- [2] Gunther, T. Rucker, C. and Spitzer, K. (2006a). Three-dimensional modelling and inversion of DC resistivity data incorporating topography I. Modelling. Geophysical Journal International, 166:495-505.
- [3] Hansen, F. (2019). The use of common-offset and multiple-offset gpr methods for forensic investigations.



Master Thesis: Geotextile Tubes Filled with Mine Tailings as a Construction Element

By P. Bosman

This master thesis is a project from IHC Mining & Tunnelling and NETICS. IHC Mining & Tunnelling is a business unit of Royal IHC, focussed on designing equipment for both the mining and tunnelling industry. NETICS, is an engineering company, focused on research and business development in building with soft dredged sediments for re-use civil engineering. A client came to IHC with the request to reinforce tailings dams. IHC teamed up with their partner NETICS to work together to find a solution for this challenge. Working together on this project meant that both companies could combine their core strength in solving this unique business case. I was assigned on this project as a master thesis internship. For the duration of my master thesis internship at IHC and NETICS, I spend most of my days working both at the office at IHC Mining & Tunnelling and NETICS. Both companies made me feel welcome and were eager to share their knowledge with me and help me wherever they could.

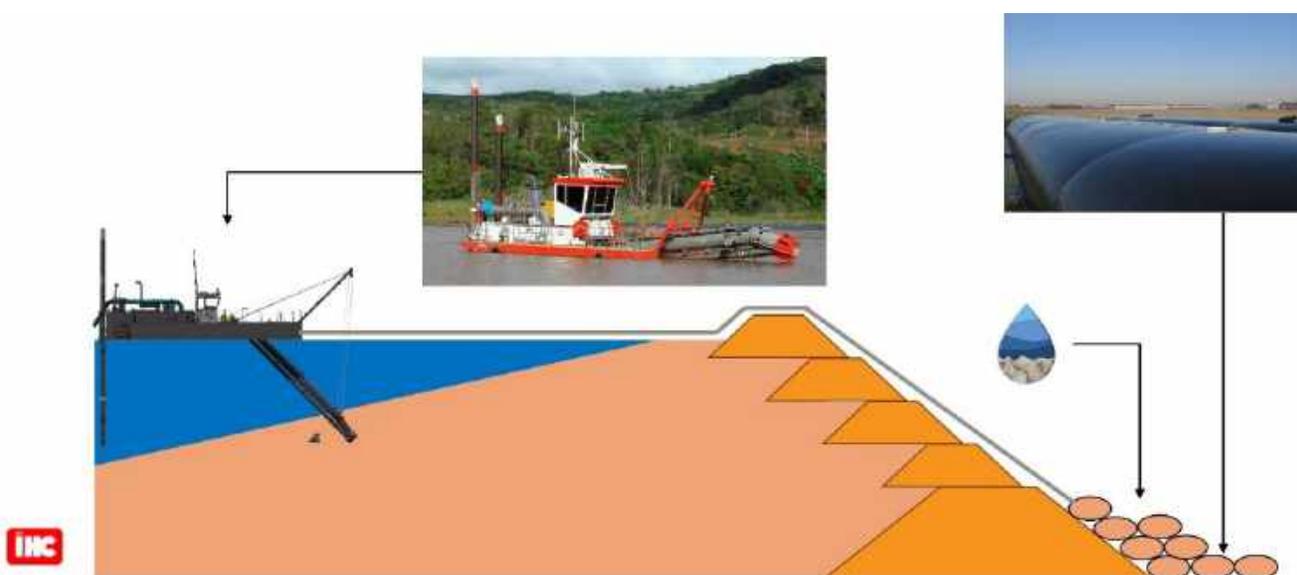
Introduction

In the last 25 years, there have been a couple of serious accidents with mine tailings storage facilities. Even more recent, in the beginning of the year 2019, there was a big tailings dam failure in Brazil, resulting in 248 casualties and 22 missing individuals [British Broadcasting Corporation, 2019] and a big environmental impact on the lower regions of the flood area. It is without a doubt that mine tailings dam failures prove very dangerous. Together with the large environmental impact tailings storage facilities have in general, with big water consumption, large areas used for storage and the acid mine drainage phenomenon [Kefeni et al., 2017], there is an increasing pressure on mining companies to reduce the amount of tailings storage facilities and to reduce the

environmental impact which these facilities have on their surroundings. Nowadays, there are many different methods that can be used to reduce the volume of mine tailings produced. One of these methods is to re-use mine tailings as a potential resource for construction material. A picture of the concept solution is shown in the schematization below. The plan is to use the equipment designed by IHC and combine this with the knowledge from NETICS on the use of geotextile tubes for dewatering purposes. However, the biggest problem of mine tailings in general is that mine tailings dewater very slow and that the geo-mechanical properties of the resulting dry material do not meet the requirements that are needed to be used in construction work.

Therefore, the mine tailings have to be treated to make them suitable as a resource for construction purposes. With this in mind, this research focuses on the potential stabilisation of mine tailings in order to make it a suitable resource for construction purposes while retaining any contaminants initially present in the mine tailings. Therefore, it was my job to answer the following question:

Are mine tailings an alternative resource for construction with geotextile tubes?



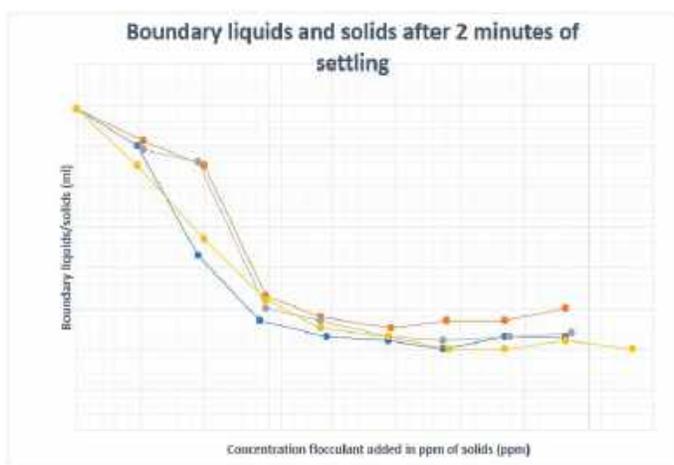
▲ Figure 1: The concept solution, courtesy to IHC for providing this picture.

Methodology

To answer the research question of this study, a series of experiments were performed on iron ore tailings, focussed on flocculating, binding and dewatering behaviour of iron ore tailings in geotextile tubes. These samples were taken from a tailings dam belonging to an iron ore producing mine. Therefore, the composition of the iron ore tailings corresponds with the composition of iron ore tailings in general. The tests performed were a series of jar tests, geotextile cone tests and hanging bag tests.



Figure 2: Me, in the laboratory of IHC, performing the tests. ▶



Results

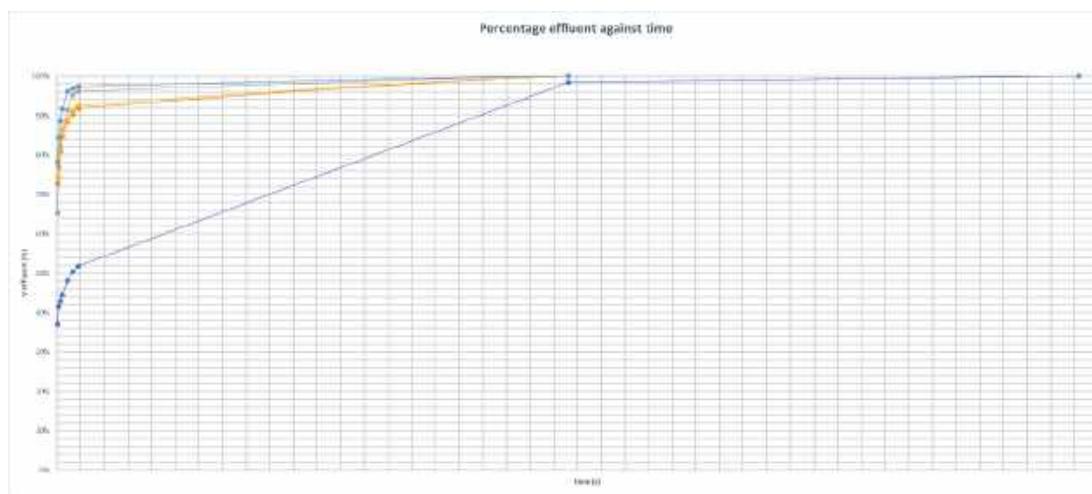
The results from tests show that the iron ore tailing can be flocculated successfully. The more flocculant added, the faster the solids settle. This continues till a certain level is reached, where adding more flocculants did not result in a faster settling rate.

The results from the hanging bag tests are shown in the figure below. It is clear in this picture that the dark blue line takes the longest time to reach 100% of dewatering, meaning that the dewatering rate is the slowest for this mixture. Both the light blue and the grey line reach 100% of dewatering in the fastest way, meaning that these two mixtures have the highest dewatering rate.

◀ Figure 3: Results from the jar tests.

Conclusion

The mine tailings on which the tests were performed had a grain size that was too small for geotextile tubes to be used. In order to prevent the flushing out of particles, the mine tailings were flocculated, stopping the mine tailings from flowing through the pores. In addition, the slurry was made pumpable by slurrification, making it suitable for transport by pumping. Lastly, the contaminants in the mine tailings were stabilised and solidified. This remediation method proved successful in stabilising the contaminants. In addition, the remediation method resulted in development in strength. Based on the three statements above, it was concluded that the enhanced properties of the mine tailings make them suitable to be used as a resource for construction with geotextile tubes. NETICS will use this study for the next phase which will focus on the engineering of structures which will de-risk the dams and increase the safety of the area.



▲ Figure 4: Results from the hanging bag tests.

References

- British Broadcasting Corporation (2019). Brazil dam disaster firms to face criminal charges. <https://www.bbc.com/news/world-latin-america-49772778>.
- Kefeni, K., Msagati, T. A. M., and Mamba, B. (2017). Acid mine drainage: Prevention, treatment options, and resource recovery: A review. *Journal of Cleaner Production*, 151:475–493.



Weber Puzzle

Important Mines or Mining Areas

By K.WEBER

Where are the following important mines or mining areas located?

1. Very large craterlike pit which started as a surface mine. But because the pipe containing a valuable mineral continues downwards, it was mined from the side to a depth of over 1000 m. Britain annexed the area to get hold of the mine.
2. Huge open-pit iron mine which, after removing the ore next to the town, led to demolishing the part of the town overlying the extension of the ore body.
3. Gigantic open-pit copper mine worked since 1975, producing 737 million pounds of copper by 2017, making it the biggest producer of the region where more porphyry-copper ore bodies occur.
4. Large area overlying a thick brown coal layer in which at several locations extensive mines are being exploited. With giant excavators the topsoil is removed. Villages have to be moved but reconstruction of the landscape is promised. For this puzzle you should mention the mine, often visited by the MV, which is well remembered by the nice barbecue pit.
5. At an elevation of over 4000 m there lies a mining town from where already for a very long time the surrounding 4890 m high mountain is mined. The mountain contains the highest concentration of silver in the world. It is very likely that Piet Hein's silver largely originated at this mountain.
6. After finding gold in this region in 1851 a gold-rush resulted. Gold placers were mined as well as underground river gravels as shown. The little town after which the region is called has an interesting gold museum and one can visit an underground mine.
7. False colour satellite photograph showing a giant meteor crater is the site of a series of large and deep goldmines. It is probably the largest gold concentration which is mined anywhere in the world.
8. Motor house serving the hoist and pump of a tin mine of a type well known from a recent TV series. The area already produced kassiterite in pre-historic time for the manufacture of bronze.



1



2



3



4



5



6



7



8

Win a crate of Beer
By following these easy steps

- 1 Make the WeberPuzzle
- 2 Take your best winner selfie
- 3 Send your answers and your winner selfie to our email before the 14th of June
email: naturalresource-mv@tudelft.nl

Winner will be announced in the next edition

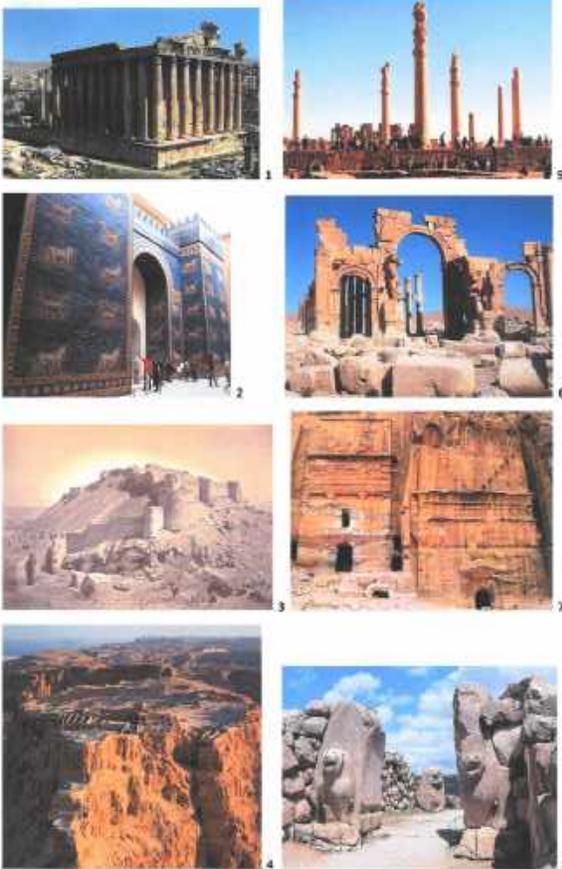
Glück Auf!



Weber Puzzle Solution

Archeology for Petroleum Engineers

By K.WEBER



1. The beautiful temple of Bacchus forming part of the spectacular ruins of Baalbek in Libanon dating from Byzantine times.

2. The famous Ishtar gate of Babylon in Iraq. The facade was dismantled and is now exhibited in the Pergamon museum in Berlin. The remains of the gate are still in place.

3. The Belar Hissar fortress on the northern side of Kabul in Afghanistan. Used as a palace of succession of Khans it was one of the focusses of the series of wars between Afghanistan and Great Britain between 1840 and 1920. This was the time of the so called Great Game to prevent a Russian penetration into Afghanistan threatening India.

4. The fortress of Masada in Isreal to the SE of Jeruzalem. Ruins of parts of the palace of Herodes can still be seen but the main interest is formed by the siege of Roman troops under Titus It was the last remaining stronghold of the revolutionary Zealots. When the Romains, after building a ramp to the top were ready for their final assault, the entire Jewish group including women and children were killed by their own hand. (73 AD)

5. The Apadana Palace of Xerxes at Persepolis Iran, demolished by Alexander the Great in 331 BC.

6. Triumphal Arch at Palmyra in northern Syria. The IS has destroyed much of the beautiful ruins.

7. Rock Tombs at Petra in Jordan near the old Nabatean settlement.

8. The Lion Gate at Hattusas neat Bogaskoy in Turkey. This is the oldest of the ruins remaining of the Hittites in 1600 BC.

The previous quarterly puzzle winners are
Lucas Tan and Gabriel Franco

Other correct submissions:
Lauran de Jong
Samuel Tupperware

GRADUATION SUBJECTS

Dr Ir W. Broere

Daniel Dobrovinski: "Bored tunnel lining behaviour in discontinuous rock"

Dr Ir W. Broere

Michiel Vonk: "Grouting the tail void"

Professor Dr C. Jommi

Lars Rook: "Development of an Erosion Function Apparatus for the assessment of the erosion resistance of compacted clay"

Professor Dr K.G. Gavin

Dylan van Opdurp: "Geotechnical characterization of sediments from the Rockall Bank Slide Complex"

Dr F. Pisano

Davini Kalløe: "Improving the quality control of Cofra Roller Compaction: A study on the relation between the impact acceleration and the soil compaction"

Dr P.L.J. Zitha

Abdulaziz Fattah: "Hybrid polymer-based system for EOR at High salinity and high temperature: experiments"

Dr P.J. Vardon

Jasper Snoeren: "The influence of freezing-thawing cycles on the geotechnical performance of an end-bearing energy pile"

Professor Dr C. Jommi

Antoine Gori: "The unexpected softening of the undrained shear strength of organic and silty clays in Rhine delta: a conceptual study"

Dr Ir D.J.M. Ngan-Tillard

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UPCOMING Events



#STAYATHOME

Colophon

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Cover

Sentinel 2 Playground
21-01-2020 over Niger Delta

Poster

Photo taken by Bjørn-Kristian Johannessen
Location: Ågotnes Harbour, Fjell, Norway

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