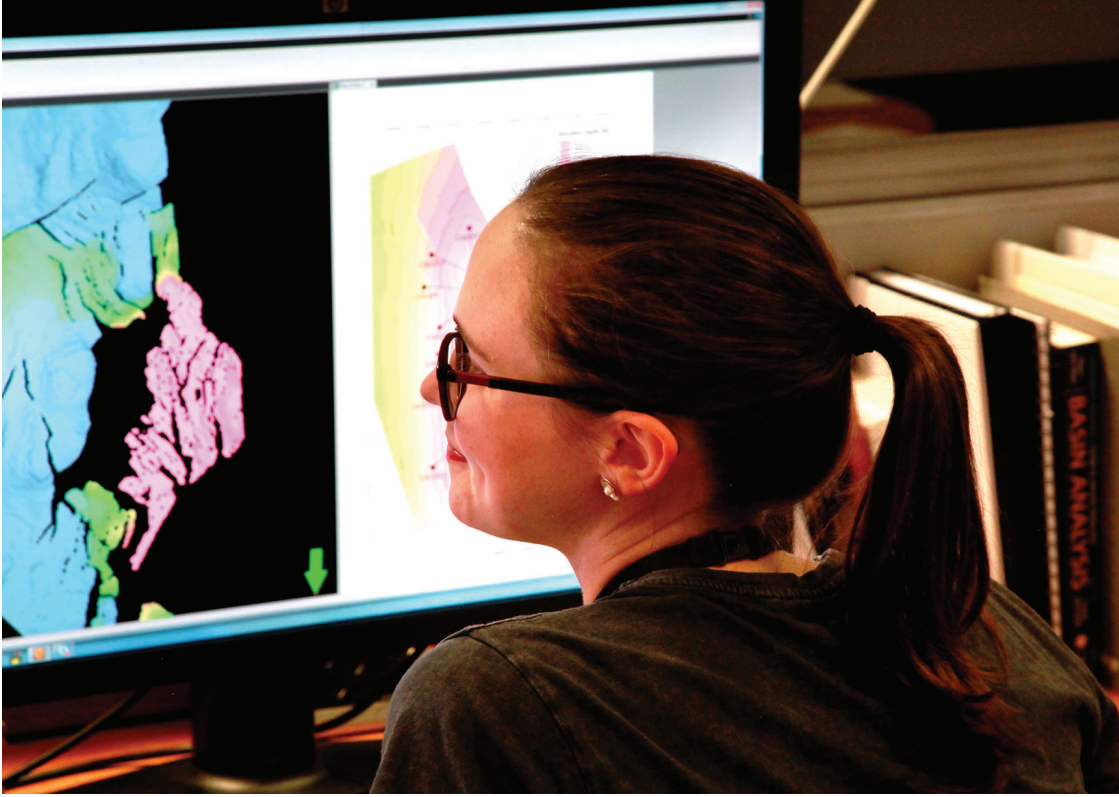
12th Earth Scientific Congress

Organised by:

Geological Society Miölnir



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Geological Society Miölnir

The Geological Society Miölnir finds its roots in Earth Sciences students of Utrecht University who were a member of the student society 'Unitas S.R.'. The society started off as a group of students sharing an interest in geology, geophysics and geochemistry, as well as in the leisure that is typically associated with social gatherings of earth scientists. In the 35 years that followed, these elements have remained, but the social bonding has proven so strong that members came, but didn't leave. Bi-annual excursions are now frequented by first-year undergraduates and professors, master students and senior industry personnel. As a result, G.S. Miölnir has become a platform for friendship and leisure, advice and recruitment, with national as well as many international members.

Since 1993, 11 congresses have been organized, covering a wide range of earth scientific topics. This 12th edition has speakers that almost exclusively find their earth scientific roots within the Geological Society Miölnir. This colloquium will celebrate the successes of former society members in international science and industry.

March 9th 2018 / Minnaert 2.01, Leuvenlaan 4, Utrecht

Preface
Praeses Lustrum committee

Dear attendees,

Welcome to the 12th earth scientific congress organised by Geologisch College Miölnir, in honour of its 35th anniversary.

This event has been organised through a joint effort of current student members and alumni. All of the speakers are alumni of our society. I think this illustrates not only that Miölnir is vibrant as ever, but also that it has fostered remarkably strong ties between earth-science students of different generations.

We are pleased to present a very diverse programme. It is clear that studying earth sciences in Utrecht can lead to many different career paths. I hope this is inspiring to the students attending this event. I also hope it will maybe spark a few new ideas in participating professionals, like myself. Opportunities to hear presentations on topics far outside the focus of one's own specialisation are rare, but in my experience they can sometimes lead to fresh ideas and interesting joint projects.

Of course, like any conference, this event is also intended as an opportunity to socialise. Whether you want to have a serious discussion about rocks with one of the speakers, or just catch up with old friends, I hope you will not only join us for lunch, but also for the borrel after the talks. Beer will be provided.

Mea navis aericumbens aguillis abundat!

Aart-Peter van den Berg van Saparoea
Praeses Lustrumcommissie Geologisch College Miölnir

Program

8.30 Registration

9.00 Introduction President G.S. Miönir *(Lennart Hanemaaijer)*

Session 1

Convener: Jaap Hendriks

9.10 "Working on waterquality: How to deal with microplastics, pharmaceuticals and politics" *(Steffie Paardekooper, Ministry of Infrastructure and Water Management, the Netherlands)*

9.30 "Subsidence of the Mekong delta (Vietnam): Will it become the next Atlantis?" *(Philip Minderhoud, Utrecht University, the Netherlands)*

9.50 "Hominin Sites and Paleolakes Drilling Project (HSPDP): Drilling into our African roots" *(Mark-Jan Sier, University of Oxford, UK)*

10.10 "Climate and carbon cycle change during the Middle Eocene Climate Optimum" *(Robin van der Ploeg, Utrecht University, the Netherlands)*

10.30 "What is a trace of life, and what is not? Complex, (self-)organized structures in the rock record" *(Mark van Zuilen, Institut de Physique de Globe de Paris, France)*

10.50 Coffee break

Session 2

Convener: Hanna van de Mortel

11.20 "Plio-Quarternary tectonics and changes along the Hellenic forearc (Greece)" *(Gino de Gelder, Insitut de Physique de Globe de Paris, France)*

11.40 "Geodynamic modeling of convergent and divergent margins: linking mantle dynamics and surface observations" *(Anne Glerum, GFZ Potsdam, Germany)*

12.00 "Geochemical and temporal evolution of magmatism in the Aegean region: implications for slab roll back and slab tearing" *(Pieter Vroon, Vrije Universiteit Amsterdam, the Netherlands)*

12.20 "On marble, microscopy and the conservation of cultural heritage" *(Martine Vernooij, ETH Zürich, Switzerland)*

12.40 Lunch

Session 3

Convener: Marc Nijboer

13.30 "The flow of polar ice sheets" *(Paul Bons, Tübingen University, Germany)*

13.50 "Good vibrations: imaging the earth's deep interior using earthquakes" *(Arwen Deuss, Utrecht University, the Netherlands)*

14.10 "Digging for gold with a continental plow" *(Douwe van Hinsbergen, Utrecht University, the Netherlands)*

14.30 "Geometallurgy, or the optimal use of geoscientific data throughout the life of a mining project" *(Pim van Geffen, Vancouver Geochemistry, Canada)*

14.50 Coffee

Session 4

Convener: Naomi Berkhout

15.20 "Exploration in the Netherlands"
(Annemiek Asschert, Energie Beheer Nederland)

15.40 "Dinantian Carbonates are hot!"
(Bastiaan Jaarsma, Energie Beheer Nederland)

16.00 "Petroleum exploration in the Upper Cretaceous of the deepwater Tano Basin"
(Marco van Hattum, Springfield E&P, Ghana)

16.20 "Shell energy scenarios"
(Peter vd Wouw, Shell exploration and production, the Netherlands)

16.40 Social drinks

Session 1

"Working on water quality: How to deal with microplastics, pharmaceuticals and politics"

Steffie Paardekooper
Ministry of Infrastructure and Water Management, the Netherlands

Steffie Paardekooper received an MSc in Physical Geography in 2009 at University Utrecht. She specialized in quaternary geology and did her thesis on the Geomorphology of the Caledonia Channels, New York. After graduation Paardekooper started as a trainee at the Dutch government. Since 2011 she works at the Ministry of Infrastructure and Water Management. For several years Paardekooper worked on the Delta programme, which focuses on the effect of climate change in the Netherlands in the next century. As project leader she was responsible for the Delta Plan on Freshwater Supply which contains the measures and studies pertaining to the availability of fresh water in the Netherlands. Since 2015 her main focus is on water quality. In 2016 she contributed to the ambitious declaration for improving the water quality in the Netherlands, which was signed by three ministries and all authorities and NGOs involved. Now she and her team see to the execution of the made agreements.

Working on water quality – How to deal with microplastics, pharmaceuticals and politics

Clean water is of vital importance. For people, for plants and for animals. To improve water quality, the government sets national and international requirements and takes measures, for surface water, drinking water, bathing water and ground water. Even waste water must meet certain standards because, after treatment, this water is released back into the environment. But there are also emerging contaminants for which there are no requirements (yet). Examples are microplastics and pharmaceuticals. The information for these contaminants is often limited; how much enters the water system? Is it toxic? And new anthropogenic substances are created every day. How to act when information is limited, measures are expensive and the effect not yet known. How can we make sure our drinking water stays safe, and we can still swim on a nice summer day?

"Subsidence of the Mekong delta (Vietnam): Will it become the next Atlantis?"

Philip Minderhoud
Utrecht University, the Netherlands

Minderhoud received his MSc (2012) in Quaternary Geology & Physical Geography at Utrecht University with a thesis on dating the soil erosional history in Tanzania. From 2013-2015 he was a lecturer at Earth Sciences at Utrecht University, teaching and supervising in an wide array of courses, excursions and field works. He was awarded teacher talent of the Geosciences faculty in 2014. From 2015 onwards he is doing his PhD research at Utrecht University on subsidence processes in deltas with focus on the Mekong delta in Vietnam. In this research he combines different disciplines: geology, hydrogeology, geotechnical modelling and remote sensing analyses to unravel the subsidence signal in the delta. After multiple trips to Vietnam for data collection and fieldwork, he is now in the final year of his PhD, finishing his thesis.

Subsidence in the Mekong delta, Vietnam: Will it become the next Atlantis?

The Vietnamese Mekong delta, the third's largest delta in the world, is experiencing annual subsidence rates up to several centimeters. As the delta is only elevated slightly above sea level, these sinking rates seriously threaten the deta delta with increased flooding, salinization and, ultimately, permanent inundation. Subsidence of the Mekong delta is the result of a combination of factors. In this talk I will provide an overview of the main subsidence drivers in the delta. A lead role is reserved for the extraction of groundwater, but also for natural subsidence following delta evolution and land use practices. What matters for the Mekong delta at the end of the day is elevation above sea level. By combining recent research results with an newly created elevation model, I will elaborate on the question whether the Mekong delta will have a future above or below sea level.

"Hominin Sites and Paleolakes Drilling Project (HSPDP): Drilling into our African roots"

Mark-Jan Sier
University of Oxford, UK

Mark Jan Sier studied Geology in Utrecht and received an MSc in 1999. While working for ING bank Amsterdam he decided to study archaeology in Leiden. Starting his first year in 2004 and receiving an MA in Palaeolithic Archaeology in 2008. He received his PhD in Leiden in 2013 and his thesis was titled: Neandertals in the forest: A palaeomagnetic study of the Eemian interglacial stage deposits from north western and central Europe. After his PhD he did a post-doc at Utrecht's Fort Hoofddijk paleomagnetic laboratory and currently he is a post-doc at the University of Oxford. His current research is mainly focussed on the geochronology human evolution sites in Europa (Atapuerca, Happisbourgh, etc) and Africa (Afar, Turkana, Gorangosa etc). He is married to paleoanthropologist Maria Martinon Torres and they have two children.

March 9th 2018 / Minnaert 2.01, Leuvenlaan 4, Utrecht

"Climate and carbon cycle change during the Middle Eocene Climate Optimum"

Robin van der Ploeg
Utrecht University, the Netherlands

Robin studied Earth Sciences at Utrecht University, where he received his BSc in 2012 and his MSc in 2014, both with the distinction cum laude. Since 2014, Robin has been working as a PhD Candidate at the Department of Earth Sciences at Utrecht University. His PhD project is focused on climate and carbon cycle dynamics of the Cenozoic, with an emphasis on the Eocene greenhouse world and the Middle Eocene Climatic Optimum. Within this scope, research subjects include the behavior of the silicate weathering thermostat, reconstructions of atmospheric CO2 concentrations and ocean temperatures, as well as ocean carbonate and trace element chemistry. Robin is also the owner of The Biogeologist (www.biogeologist.com), a website featuring news updates from the natural sciences and background articles on subjects like geology, wildlife and climate.

Climate and carbon cycle change during the Middle Eocene Climate Optimum

Climate and carbon cycle change during the Middle Eocene Climatic Optimum (MECO)
Reconstructions of climate perturbations in the geological past offer a unique window on the sensitivity of the Earth system and are essential in order to better predict future climate change. One of the key climate events of the Cenozoic is the Middle Eocene Climatic Optimum (MECO), which represents a ~ 500 kyr episode of global ocean and atmosphere warming that occurred ~ 40 Myr ago, superimposed on the long-term Eocene cooling trend. The MECO is generally associated with a rise in atmospheric CO2 concentrations and carbonate dissolution in the deep oceans, but its cause remains enigmatic. In this talk, I will highlight several studies from my PhD project aimed towards better gaining a better understanding of the causes and consequences of this event. In particular, I will address reconstructions of the silicate weathering response, the change in atmospheric CO2 concentrations and the amplitude of sea surface warming during the MECO.

"What is a trace of life, and what is not? Complex, (self-)organized structures in the rock record"

Mark van Zuilen
Institut de Physique de Globe de Paris, France

Van Zuilen received an MSc (1997) in Geochemistry at Utrecht University, and a PhD (2003) at the University of California San Diego, USA, on graphitic rocks of the Isua Supracrustal Belt, Western Greenland. In 2003-2005 he was a Marie-Curie post-doc at Centre de Recherche Pétrographique et Géochimique (CRPG) in Nancy, France, working on in-situ isotope analysis of Archean carbonaceous cherts from the Barberton Greenstone Belt, South Africa. In 2005-2006 he was a CNRS post-doc at the Institut Physique du Globe de Paris (IPGP), France, and was subsequently recruited as CNRS Research Scientist at IPGP, working on the nature and habitat of early life on Earth. From 2008-2010 he was a Research Scientist at the Centre of Excellence in Geobiology at the University of Bergen, Norway, studying remnants of ancient life in ICDP drill cores of arctic Russia, representing the Neoarchean-Paleoproterozoic Transition Period. Since 2010 he is a CNRS Research Scientist in the Geomicrobiology group at IPGP, France, where he currently is the principal investigator of project TRACES (2015-2020), funded through an ERC Consolidator Grant, focusing on fossilization processes of microorganisms. In 2017 he received his Habilitation (HDR) at IPGP. He is married to geochemist Kirsten van Zuilen and together they have a son Elias.

What is a trace of life, and what is not? Complex, (self-)organized structures in the rock record

Reconstructing the nature and habitat of ancient life is a difficult task that strongly depends on the study of rare microfossils and remnant microbial mats in the early rock record. The preservation of such organic structures critically depends on rapid entombment in a mineral matrix. The most important of these appear to be silica (SiO_2) matrices. Throughout the Precambrian the oceans were silica-enriched, leading to the formation of chert (silica) deposits that could effectively incorporate remnant microbial cells and mats. As we trace this record of life back in deep time, however, three obstacles are encountered; 1) mineralized microorganisms and microbial mats lack sufficient morphologic complexity to be distinguished from

certain abiologic structures, 2) early habitats of life were dominated by hydrothermal processes that generate abiologic organic compounds that can be absorbed by certain abiologic structures, and 3) metamorphism caused variable degradation of any primary remnant of life, and introduced secondary morphological and geochemical artifacts. Overall, we are thus left with an incomplete record of life that becomes increasingly controversial as we study progressively older rocks. Here an overview is given of the transformations that occur in microbial materials during silica entombment and prograde metamorphism. Recent results of experimental silicification of microbial cells are presented, followed by detailed studies of preserved cyanobacteria in modern hot spring silica sinters, and carbonaceous microstructures in Early Archean chert deposits. The critical differences will be described between abiologic microstructure artefacts such as carbonate-silica biomorphs and true microfossils in hydrothermal cherts. Furthermore, the biogenicity of laminated structures in silica sinters is discussed. Finally, an assessment is made of the potential for tracing life in the oldest, most altered part of the rock record.

Session 2

"Plio-Quarternary tectonics and changes along the Hellenic forearc (Greece)"

Gino de Gelder
Insitut de Physique de Globe de Paris, France

De Gelder did his BSc (2008-2011) mainly in Earth Sciences at Utrecht University, although two periods in the Middle East Technical University in Ankara familiarized him with research abroad and Anatolian tectonics. His MSc (2011-2014) was in Earth Surface and Dynamics at Utrecht University, but also brought him to the Victoria University of Wellington for a thesis on Holocene paleomagnetic variations, to the European Center for Geodynamics and Seismics (Luxembourg) for a project on volcano-seismology, and back to Turkey for a project on subduction-initiation. His PhD was in the Institut de Physique du Globe de Paris on Pliocene-recent tectonics within the Hellenic forearc, which he finished in October 2017. Since this year he is a post-doc at that same institute, funded by an IODP-France scholarship in relation to his participation to IODP-expedition 381 on Corinth active rift development. He is living together with his girlfriend Dilruba in a tiny but charming Parisian apartment.

Plio-Quaternary tectonic changes along the Hellenic forearc (Greece)

The Hellenic subduction zone is the fastest converging plate boundary of the Mediterranean, and the Corinth Rift is its fastest extending region. This talk will focus on when, how, and why vertical tectonic movements of the Hellenic forearc have evolved since the propagation of the North Anatolian Fault (NAF) into the Aegean domain (~5 Ma). Pleiades-based Digital Surface Models (DSMs) of 2m-resolution in 3 key areas (Corinth, Kythira, E-Crete) provided the basis for tectonic, geomorphic and structural basin analysis, which I used in combination with biostratigraphic and cosmogenic nuclide dating and numerical modelling. Onshore uplift rates in Corinth from marine terraces were re-assessed using the DSM, and combined with offshore seismic data to obtain long-term slip rates and the full elastic-flexure geometry of the master fault system. Both Kythira and eastern Crete record a similar vertical motion history, with Tortonian- Pliocene sedimentary basins bounded by trench-parallel normal faults evidencing minor, probably local subsidence during that period. E-W extension became the dominant mode of deformation in the forearc high since ~2.0-0.7 Ma, associated with uplift of several hundreds of meters, and possibly accompanied by N-S shortening south of Crete. The timing of these changes is remarkably similar to the onset of rifting in Corinth, and lends support to Anatolian-Aegean tectonic models that propose rapidly changing boundary conditions at the micro-plate scale.

"Geodynamic modeling of convergent and divergent margins: linking mantle dynamics and surface observations"

Anne Glerum
GFZ Potsdam, Germany

Anne Glerum received a BSc (2009) in Earth Sciences and an MSc (2012) in Geophysics at Utrecht University (UU). After a traineeship at Fugro Survey, she returned to the UU for a PhD in Geophysics. Her PhD work in the Mantle Dynamics group focused on the sensitivity of surface observations to mantle dynamics. Using numerical models of the present-day Eastern Mediterranean she quantified the effect of density-difference induced mantle flow, plate motions, slab geometry and lithosphere heterogeneity on the crustal deformation of the Aegean-Anatolian region. Her current project in the Helmholtz Young Investigator Group CRYSTALS (GFZ Potsdam) aims at understanding continental rift dynamics on a regional scale. In particular, she investigates the role of structural inheritance and magma-tectonic feedback in the East African Rift System.

Geodynamic modeling of convergent and divergent margins: linking mantle dynamics and surface observations

Observations of Earth's surface deformation carry information about the underlying mantle dynamic processes. Through numerical modeling we can test the degree of coupling between these crustal tectonics and mantle dynamics. In particular at plate boundaries, crust-mantle coupling is expected to play a big role, i.e. where lithosphere subducts into the mantle or where plates diverge and mantle material rises up. Here I'll discuss two case studies regarding the Eastern Mediterranean and the East African Rift System.
The Eastern Mediterranean is a well-studied area with abundant geological and geophysical data available to build as well as constrain our models of the present-day subduction system. We thus create a 3D synthetic geometry of the crust-lithosphere system, including the present-day plate configuration and crust and lithosphere thickness variations. Seismic tomography models guide the synthetic geometry of the Aegean slab and the temperature structure of the sublithospheric mantle. Absolute plate motion velocities are prescribed at the model

sides, while a free-slip surface accommodates internal deformation. In short, forcing in our models comprises lateral pressure gradients, mantle buoyancy and forcing related to the prescribed plate motions.

Based on the above initial and boundary conditions, we obtain model predictions of the present-day regional flow and stress field. Focusing on the crust, these represent predictions of the GPS velocity field that we can compare to actual GPS data, showing a good overall fit. Subsequent models include constructed variations in slab morphology, mantle structure and boundary conditions that either improve or lessen our fit to the GPS velocity field and help determine the controls of mantle dynamics on the present-day tectonic deformation in the Aegean region.

The East African Rift System (EARS), the world's largest currently active continental rift, is characterized by orthogonal and oblique rift sections, multi-phase extension histories as well as magmatic and a-magmatic branches. Hence it constitutes an extensive natural laboratory for research into the 3D nature of continental rifting. For example, GPS velocities show an anti-clockwise rotation of the Victoria microplate situated between the eastern and western branch of the EARS. Our models of the last 10 My of rifting history, including a data-based crust-lithosphere structure and topography-driven deformation, that fit this rotation help us to isolate the relative contributions of each of the rift branches and the upper mantle flow to the present-day plate motion.

"Geochemical and temporal evolution of magmatism in the Aegean region: implications for slab roll back and slab tearing"

Pieter Vroon
Vrije Universiteit Amsterdam, the Netherlands

Vroon received an MSc (1987) and a PhD (1992) in Geochemistry from Utrecht University on volcanics from the Banda and East Sunda Arcs. He was a post-doc at Royal Holloway and New Bedford College (University of London) from 1992-1996 and a senior scientific officer at the NIGL, British Geological Survey, Keyworth, UK from 1996-1997. During 1997-2003 he was laboratory manager at the Vrije University Amsterdam, and from 2003 until 2012 an assistant professor (UD). Since 2012, Vroon has been an associate professor (UHD) in the Geology and Geochemistry group of the VU, using traditional and non-traditional isotopes in solving problems ranging from planetary core formation to the generation of large volumes of rhyolitic magma in island-arcs.

Geochemical and temporal evolution of magmatism in the Aegean region: implications for slab roll back and slab tearing

Geochemical and temporal evolution of magmatism in the Aegean region: Implications for slab roll back and slab tearing
The collision of the African continent with the Eurasian plate in the eastern Mediterranean has resulted in a very complex subduction system with slab roll back and slab tear as important tectonic processes. This slab tear underneath western Turkey has resulted in a clear geochemical signature in the volcanics of western Turkey. However, the influence of the slab tear window on the volcanics of the active Aegean arc and older volcanics of the Aegean sea region has been less well studied. In this presentation, new evidence will be presented on the precise timing of the opening of the slab tear underneath western Turkey and how hot asthenospheric mantle flowing through this slab tear has influenced the composition of magmas at least 250 km further to the west.

March 9th 2018 / Minnaert 2.01, Leuvenlaan 4, Utrecht

"On marble, microscopy and the conservation of cultural heritage"

Martine Vernooij
ETH Zürich, Switzerland

1996-2001 Geology study at Utrecht University, diploma thesis in the Experimental Rock Deformation/HPT-Lab. 2001-2005 PhD at ETH Zurich on "Dynamic recrystallisation and microfabric development in single crystals of quartz during experimental deformation". 2006-2009 Postdoc and 2009-2011 Researcher at Empa (Swiss Federal Laboratories for Materials Science and Technology) and the University of Fribourg. In charge of electron microscopic imaging and analytics, projects on air pollution, conservation of museum objects and material development for the solar cell, watch and tool industry. 2012 and 2014-2015 Associated Researcher in focusTerra, the Earth Science Research and Information Centre of ETH Zurich. 2012-2015 Researcher at the Institute of Historic Building Research and Conservation of ETH Zurich. 2015-2017 Curator of the ETH materials collection for architecture, art and design. Since 2016 Scientific Coordinator for the ETH Zurich Executive Board.

On Marble, Microscopy and the Conservation of Cultural Heritage

In ancient Rome marble was a luxury product and a sign of special status, also illustrating a claim to power. The material has kept this meaning until today. Until 1900 the term marble was not only used in the current geological sense (for metamorphic limestone), but was used for all sorts of polishable stones, including variously coloured rocks types like granite, porphyry or alabaster. The multi-coloured Roman "marble" aesthetics have influenced the history of architecture across the entire western world. In the 19th century architects presented natural stones in a skilful interplay with imitated counter-pieces and also ancient spoils. At the same time, modern geology was established, ancient roman buildings were excavated and industrial research was advanced to invent new building materials and pigments. The newly acquired knowledge was broadly communicated to the public by novel handbooks and the first academic journals. In this project, I have traced the influences of scientific and industrial findings on prestigious 19th century architecture by analysing the role of natural and imitation stones in four case studies: the "Königsbau" of the "Residenz München", the "New Hermitage" in St. Petersburg and the "Kunsthistorisches Museum" and "Naturhis-

torisches Museum" in Vienna. Petrographic observations and chemical analyses of material samples have given an insight into new materials and production techniques and show to which extent the creative possibilities cleared the way for other synthetic stone products. The chosen examples mark different phases of the role of stone and stone imitations in architectural design. The results of this study increase the understanding of historical building practises and influence modern building conservation.

Session 3

"The flow of polar ice sheets"

Paul Bons
Tübingen University, Germany

Paul Bons studied applied structural geology in Utrecht, finishing in 1989. After his army service and PhD in 1993, he moved to Monash University, Melbourne, Australia for two successive post-doctoral research fellowships (ARC and Logan), working mainly on fluid flow and veins. In 1999 he moved to Mainz to work with Cees Passchier and since 2002 he is Professor of Structural Geology at the Department of Geosciences, Eberhard Karls University Tübingen in Germany. Over his career he has tried to better understand deformation of rocks and the resulting (micro-) structures through their simulation; first mostly by analogue modelling, later more with numerical methods. His recent work covers structures and rheology of rocks and ice, from the small to the large scale, shear localisation, central Tibetan tectonics, formation of layered intrusions, formation of veins and stylolites, as well as hydrothermal fluid flow and ore deposits.

The flow of polar ice sheets

With concerns over global warming, there is a growing interest in the flow of ice in polar ice sheets, as an increase of discharge of ice into the oceans could potentially cause significant sea-level rise. The flow of ice has two components. The first is internal shearing, because ice is a ductile rock with a non-linear viscosity. The second is basal sliding when the base of the ice sheet is not frozen to its bedrock. Recent studies suggest that up to 50% of the Greenland Ice Sheet is molten at its base, which would imply that basal sliding forms a significant part of the surface flow velocity. As a consequence, km-scale folds inside the ice sheets are explained by variable sliding rates or "slippery patches" and by melting and refreezing. An analysis of the flow field of the Greenland Ice Sheet, however, indicates that the commonly used flow law for ice, the >50 year-old "Glen's law", systematically underestimates the internal shear component at high stresses. Our new flow law reduces the area with basal melting to <10% of the ice sheet. A standard structural-geological analysis of the folds also shows that these form due to the extreme mechanical anisotropy of ice, not due to basal melting processes. Currently, all models use the outdated flow law and thus fail to make reliable predictions of the amount of ice entering the oceans in the future.

March 9th 2018 / Minnaert 2.01, Leuvenlaan 4, Utrecht

"Good vibrations: Imaging the Earth's deep interior using earthquakes"

Arwen Deuss

Utrecht University, the Netherlands

Arwen Deuss studied geophysics at Utrecht University, graduating in 1998. She obtained her PhD from Oxford University in 2002, working on the theory of whole Earth oscillations and the observation of seismic mantle discontinuities. She stayed on in Oxford as a Junior Research Fellow at University College. From 2004 to 2014, Arwen was a lecturer in Theoretical Geophysics at Cambridge University where her research on the seismic structure of the Earth's inner core was funded by an ERC starting grant. In 2014 Arwen moved to Utrecht University where she is a professor in Structure and Composition of Earth's deep Interior. Her current research focusses on using whole Earth oscillations to determine the attenuation (or damping) of seismic waves in the Earth's mantle and is funded by an ERC consolidator grant and NWO Vici award. Arwen lives in Utrecht Oost together with Almar de Ronde and their daughter Yvaine.

Good vibrations: Imaging the Earth's deep Interior using earthquakes

Tectonic phenomena at the Earth's surface, like volcanic eruptions and earthquakes, are driven by convection deep in the mantle. Seismic tomography has been very successful in elucidating the Earth's internal velocity structure. However, seismic velocity is insufficient to obtain robust estimates of temperature and composition, and make direct links with mantle convection. One of the fundamental questions that remains unanswered is the origin of the large low-shear velocity provinces (LLSVP's) in the lower mantle under the Pacific and Africa: are they mainly thermal or compositional? In order to answer this question, we will need new constraints from seismology, such as density and attenuation. I will show how we use whole Earth oscillations to image the density of the LLSVP's. The appears that the LLSVP's have a low density, which suggest that they might be thermal in origin. We are currently working on developing techniques to measure attenuation, which is key to mapping partial melt, water and temperature variations and will provide use further constraints on the origin of the lowermost mantle providing essential constraints for understanding the complex dynamics of our planet.

"Digging for gold with a continental plow"

Douwe van Hinsbergen
Utrecht University, the Netherlands

Van Hinsbergen received an MSc (1999) and a PhD (2004) in Geology at Utrecht University on Aegean tectonics. From 2004-2006 he was a post-doc at Leicester University, UK, working on deformation and intra-continental mountain building in Mongolia. In 2006-2009, he was an NWO VENI post-doc at 'Fort Hoofddijk' of Utrecht University working on Anatolian tectonics, followed by a 2009-2012 researcher position at the Norwegian Geological Survey (NGU) and the University of Oslo, Norway, focused on plate reconstructions of mountain belts (India-Asia, Banda Arc, Mediterranean, Caribbean). 2012, Van Hinsbergen received an ERC Starting Grant and an NWO VIDI grant, and was appointed Associate Professor in the Mantle Dynamics group in Utrecht. He specializes in Global Tectonics and Paleogeography and developed several geoscientific websites (www.paleolatitude.org, www.paleomagnetism.org, www.atlas-of-the-underworld.org). He is married to planetary scientist Inge Loes ten Kate and together they have two sons, Ids and Tjibbe.

Digging for gold with a continental plow

Porphyry-type copper-gold deposits (PCGDs) are generally being associated with formation above active or late-stage subduction of oceanic lithosphere. Important exceptions are the giant 3.3-1 Myr old Grasberg, Ertsberg, and Ok Tedi deposits on the island of New Guinea, which instead occur on a continental margin free of subduction since ~50 Myr ago. Here we show by combining mantle structure with plate tectonic reconstruction that these enigmatic deposits formed in a geodynamic setting combining four key elements: (i) a continental edge that is (ii) plowing through (iii) a previously and elsewhere subduction-enriched mantle wedge from which partial melt is emplaced into the overlying crust via (iv) an active transform fault system. Moreover, we show that such settings in the Americas and New Zealand also contain major gold-bearing mineralizations. Our 4-elements recipe provides a novel explanation of the hitherto enigmatic origin of the category of 'post-subduction' PCGDs and other, coeval, mineralizations, defining a promising science-base for devising future mineral exploration strategies.

March 9th 2018 / Minnaert 2.01, Leuvenlaan 4, Utrecht

"Geometallurgy, or the optimal use of geoscientific data throughout the life of a mining project"

Pim van Geffen
Pim van Geffen, Vancouver Geochemistry, Canada

Van Geffen received his MSc (2005) from Utrecht University, with a thesis on the Geochemistry of the Phoenix Cu-Ni-PGE Deposit near Francistown, Botswana. He obtained his PhD (2011) from Queen's University in Kingston, Canada, after writing his dissertation on Geochemical Indicators of Buried Sulphide Mineralisation under Sedimentary Cover near Talbot Lake, Manitoba. Since 2005, Van Geffen has worked as a geochemist with Anglo American Exploration, ioGlobal Solutions, and REFLEX Geosciences in Vancouver, Canada. He recently started his own independent consulting company, Vancouver Geochemistry. As a consultant, he has worked around the globe on a wide variety of projects in applied geochemistry and exploratory data analysis, ranging from soil and stream-sediment surveys to lithogeochemistry and geometallurgical project assessments. Van Geffen is a registered Professional Geoscientist with EGBC in British Columbia and serves on the Technical Advisory Committee of Geoscience BC and the Technology Transfer Committee of the Canada Mining Innovation Council. He is married to Maya McDonald and they live in Vancouver.

Geometallurgy, or the Optimal Use of Geoscientific Data Throughout the Life of a Mining Project

Process optimization is commonly applied in mining operations, from the building of a block model to scheduling and stockpiling, blending, crushing, milling, and metallurgical extraction. While these processes are usually integrated within operations, the data used for optimization may not include all the available information for the project. High-quality exploration data are often excluded or unavailable, leaving a great opportunity for improvement. On the exploration side, data acquisition is generally focused on targeting, grade distribution, and resource definition, and may not include parameters that would be most useful in the modeling of downstream processing, let alone tailings disposal and site reclamation. When we step back and consider the entire life of a minerals project from a geometallurgical perspective, we can identify such information gaps and implement ways to bridge them and optimize all processes along the entire value chain. Geochemical methods

can provide much of the required information, such as the content of penalty and royalty elements, acid-generating and neutralizing potential, carbon and sulfur speciation, as well as proxies for ore and gangue mineralogy, clay content, and other metallurgical performance parameters. When integrated with mineralogical and petrophysical information, this allows us to model the actual value per block, rather than just the grade, which would improve the operational success and greatly reduce the financial risk of the project.


Session 4

"(Geothermal) Exploration in The Netherlands"

Annemiek Asschert
Energie Beheer Nederland

Annemiek Asschert graduated in 2007 from Utrecht University and received a MSc in Earth Sciences. She started her workingcareer at Fugro, first as a geotechnical engineer and later as a geologist with Fugro Robertson, now CGG.
After 4 years with Fugro, Annemiek started working for EBN in 2011, the Dutch State participant in oil and gas as a geoscientist, where she is still working today. She is now part of the newly formed exploration team as a geoscientist and deputy programme manager exploration.

(Geothermal) Exploration in The Netherlands

In the Netherlands we are exploring and producing for hydrocarbons for several decades now. You could say that we are working in a mature basin and the perception of many is that there is not much to explore anymore in the Netherlands, and a majority of the infrastructure will be abandoned in the near future.
I will prove you wrong, there are still many targets to explore for hydrocarbons and exploration for geothermal energy is very much alive. I will give you an insight in which geological formations we are exploring and why we are still exploring for hydrocarbons.

"Dinantian Carbonates are hot!"

Bastiaan Jaarsma
Energie Beheer Nederland

Bastiaan received an MSc in Gepphysics at Utrecht University in 1996. He worked as geophysicist / geoscientist for various companies in the oil industry, including Clyde / Wintershall, SGS Horizon and Maersk Oil, before joining EBN (Dutch state oil company) in 2011. In EBN, Bastiaan started as project lead of exploration studies, subsequently having the same role for studies into induced seismicity of Dutch gas fields. In Summer 2017, Bastiaan joined the newly formed Geo-Energy team which focuses on renewable energy, in particularly geothermal. He is now technical coordinator of the Ultra Deep Geothermal Exploration Workprogramme, in which the potential of ultra deep geothermal from Lower Carboniferous Dinantian Carbonates will be explored across the Netherlands. Bastiaan is married to Natalie van Eckendonk, with four kids.

Dinantian Carbonates are hot!

Lower Carboniferous Dinantian Carbonates are "hot"; they form the target reservoir for active and future geothermal projects onshore the Netherlands, while at the same time the exploration for hydrocarbons in this reservoir has revived in the Dutch and British southern North Sea sectors. This reservoir is, like most carbonates, heterogeneous in many ways and at different scales. Unfortunately, the seismic and well datasets are relatively sparse and of variable quality. Learning from geological analogues is therefore of key importance to be able to predict flow performance. Proper and consistent assessment and mitigation of the technical risks is important to support business cases and subsequently execute projects in a safe and sustainable way. This again requires taking the learnings from elsewhere into account.

The UltraDeep Geothermal Exploration Work Program (EWP) is a shared exploration program of seven consortia and the Dutch government. The program is set up by the consortia together with EBN (Dutch state oil company) and TNO (Dutch national research institute). The aim is to identify three pilot projects for geothermal in the Dinantian Carbonates below four km depth. The consortia consist of different parties with a demand for high temperature energy, such as process industry (producing amongst others paper, beer, cheese or candy

bars), utility companies, a hospital, etc., spread across the Netherlands. In the program, the consortia will work together at three scales to utilize synergies and jointly lower the risks. Initially, large (basin-)scale mapping and structural analysis will take place and conceptual reservoir models will be built. Best-practices and templates for risk analysis and for well and stimulation design will be developed jointly to assure that assessments in the projects are optimal and comparable. Subsequently, consortia close to each other will apply and refine results of the first stage at a regional scale. Finally, detailed local models and conceptual well and stimulation designs are developed by individual projects to mitigate risks and support the local business cases. 2D/3D seismic data acquisition and (re-)processing will be done at the three scales, supported by the results and insights of the seismic modeling work. The program will run for up to three years. The Dutch government compensates fifty percent of the costs of the program. The outcomes of the program will be made publicly available, to support subsequent initiatives in the same play.

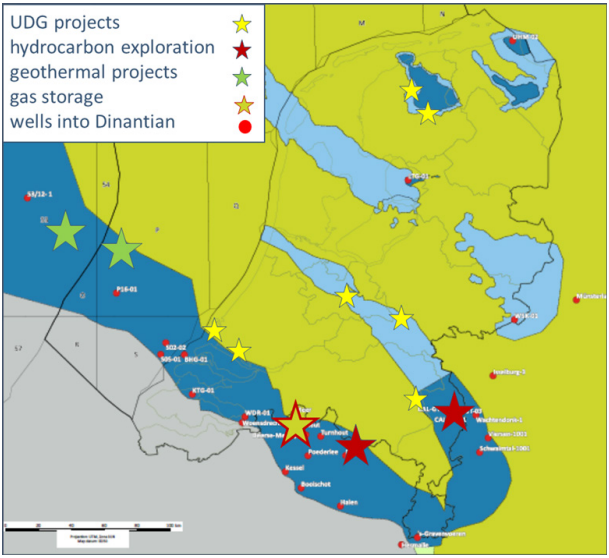

Figure 1 Distribution map of the Lower Carboniferous Dinantian carbonate platforms. Dark blue shading shows where carbonate platform development is proven by well and/or seismic data. Light blue shading indicates where platform facies is expected but direct proof is (still) missing. The stars indicate the UDG projects and other activities where Dinantian Carbonates form the main reservoir. Distribution map from Boxem et al. (2016).

"Petroleum exploration in the Upper Cretaceous of the deepwater Tano Basin"

Marco van Hattum
Springfield E&P, Ghana

Marco van Hattum received an MSc in Geology at Utrecht University in 2000, and a PhD in Geology at Royal Holloway University of London in 2005, on sediment provenance of deepwater sediments in Northern Borneo. Marco joined Shell in 2005 as an exploration geologist, and since then has worked in a variety of geoscience roles, in various locations including the Netherlands (Southern North Sea gas), Nigeria (Bonga North deepwater oil development), Brunei (enhanced oil recovery from snake wells), Malaysia (HPHT reservoir modelling) and Ukraine (onshore seismic acquisition). In 2014 Marco joined DONG Energy in Denmark, re-evaluating the mature Siri oilfield (North Sea) and proposing enhanced recovery strategies in close cooperation with reservoir engineering. In 2017 Marco joined Springfield E&P, the first privately-owned E&P company in Ghana, as their principal geologist. He currently works on the evaluation of their deepwater acreage, planning of an exploration campaign, and development options of undeveloped discoveries. Marco is a travelling and culinary enthusiast, and frequently manages to combine both passions.

Petroleum exploration in the Upper Cretaceous of the deepwater Tano Basin

The prolific Tano – Côte d'Ivoire Basin extends over the offshore areas of Côte d'Ivoire and western Ghana. It is a transform passive margin basin, which differs from other West African basins by the dominance of strike-slip transform tectonics and the absence of salt (halokinesis). Exploration for oil in Ghana has been going on since at least 1896, but the discovery of the world-class offshore Jubilee oil field in 2007 has drastically changed the scale of the industry, and has shifted focus towards deepwater acreage. Ongoing developments are also shifting focus towards gas, for the local generation of electricity and LNG exports. In this presentation, a general overview will be given of the Upper Cretaceous petroleum systems of offshore Ghana, with special focus on the acreage held by Springfield E&P. The largest oil and gas accumulations are found in combined structural-stratigraphic traps, with reservoirs of Cenomanian, Turonian and Campanian age. Source rocks are primarily Albian and Cenomanian, deposited in early Atlantic anoxic basins. After deposition of a regional top seal in the Maastrichtian, erosional events in the Oligocene-Miocene have locally affected the underlying hydrocarbon-bearing strata.

"Shell energy scenarios"

Peter van de Wouw
Shell exploration and production, the Netherlands

We have been developing possible visions of the future since the 1970s, helping generations of Shell leaders explore ways forward and make better decisions. Shell Scenarios ask "what if?" questions encouraging leaders to consider events that may only be remote possibilities, and stretch their thinking. Our scenarios also help governments, academia and business in understanding possibilities and uncertainties ahead. The focus of the presentation will be on Shell's energy scenarios and models

March 9th 2018 / Minnaert 2.01, Leuvenlaan 4, Utrecht

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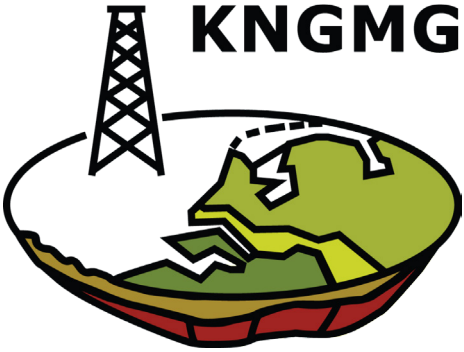
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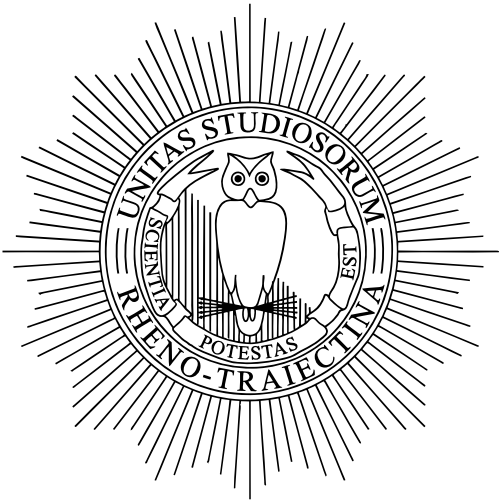
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