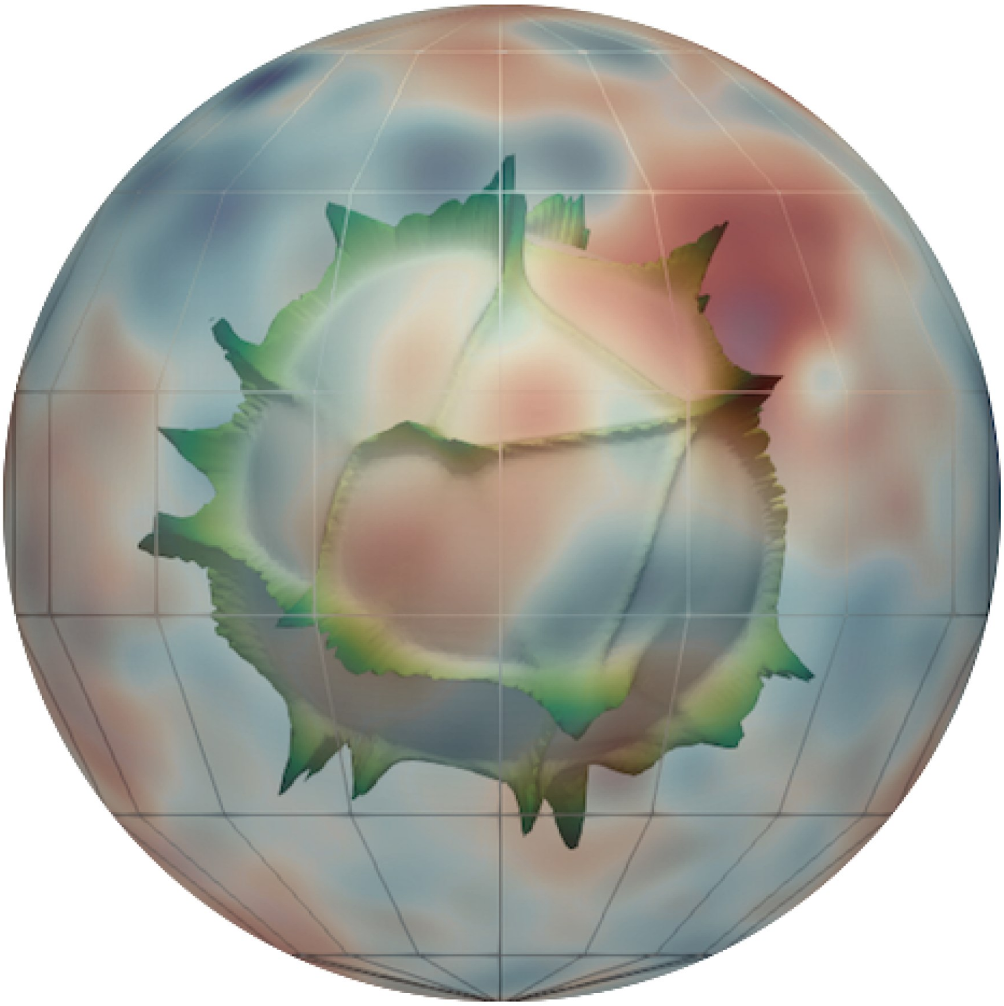
CEED ANNUAL REPORT



2017

UiO : The Centre for Earth Evolution and Dynamics
University of Oslo

Front cover: *Global, 3D spherical numerical model of the mantle and lithosphere dynamics of our neighbour planet Venus. The green contours depict regions of anomalously high temperature in the deep mantle of the planet indicating the pattern of hot upwellings. The transparent surface shows the surface geoid predicted by the model: red colours denote geoid highs, blue colours corresponding lows. Model by* ***Tobias Rolf.*** *From Rolf, T., Steinberger, B., Uppalapati, S., Werner, S.C. Inferences on the mantle viscosity structure and the post-overturn evolutionary state of Venus. Icarus (in review).*

Back cover from the top:

1: *CEED paleomagnetic group sampling Mesozoic and Precambrian intrusive rocks in SW Greenland. August 2017. Photo by a boat crew member.*

2: *Oil film sampling from the hot water stream of the Lusi mud eruption, north-east Java, Indonesia. Photo:* ***Adriano Mazzini***

3: *Helicopter pick-up after long days of field work in the Arctic mountains of Scandinavia:* ***Hans Jørgen Kjøll***

PRIMARY OBJECTIVE:

Develop an Earth model that explains how mantle processes drive plate tectonics and trigger massive volcanism and associated environmental and climate changes throughout Earth history

SECONDARY OBJECTIVES:

(1) Build a consistent global plate tectonic model for the past 1100 Ma

(2) Explore how palaeogeography and True Polar Wander have influenced the long-term climate system

(3) Develop models that link surface volcanism with processes in the deepest mantle

(4) Develop models that link subduction processes in arcs and collision orogens with the mantle

(5) Understand the role of voluminous intrusive and extrusive volcanism on global climate changes and extinctions in Earth history

(6) Develop models for mantle structure, composition and material properties

(7) Understand similarities and differences between the Earth and the other terrestrial planets

(8) Develop tools and databases that integrate plate reconstructions with geodynamic and climate modelling

CEED is dedicated to research of fundamental importance to the understanding of our planet, that embraces the dynamics of the plates, the origin of large scale volcanism, the evolution of climates and the abrupt demise of life forms.

This ambitious venture shall result in a new model that explains how mantle processes interact with plate tectonics and trigger massive volcanism and associated environmental and climate changes throughout Earth history.

Henrik H. Svensen *receives the Outreach prize from the Research Council of Norway (Oslo, November 2017. Photo: Wenche Willoch/UiO)*

ACHIEVEMENTS IN 2017

117 publications in international journals, including 13 in **high-impact journals,** and six of these had a CEED researcher as the first author.

CEED researchers were author on 4 books. **Anne Hope Jahren** won the National Book Critics Circle Award for *Lab Girl*, and **Trond H. Torsvik** and Robin Cocks received the PROSE Book Award for *Earth History and Palaeogeography*. *Volcanoes of Europe* by **D. Jerram** et al was published in its second edition in 2017.

Young Outstanding Scientist project from RCN was awarded to **Morgan T. Jones** for the project ASHLANTIC: Origin and climatic impacts of explosive volcanism during the Palaeocene-Eocene Thermal Maximum (Project started in 2017)

Young Outstanding Scientist project from RCN was awarded to **Tobias Rolf** for the project PLATONICS: Shaping planetary tectonics by solid-state convection incorporating damage and inheritance (Project starts in 2018).

Trond H. Torsvik received the Fridtjof Nansen Award of Excellence in Science

Henrik Svensen received the Outreach Prize from The Research Council of Norway

Carmen Gaina was elected as a member of the Norwegian Academy of Science and Letters

Jan Inge Faleide was awarded the Norwegian polar research prize together with Elin Darelius.

Stephanie C. Werner was elected as a member of the ESAs Solar System and Exploration Working Group (SSEWG).

Juan Carlos Afonso was awarded the Anton Hales medal from the Australian Academy of Science

International conference organized by CEED

FORM - From Orogens to Rifted Margins and Back: The formation and deformation of continental margins through Wilson Cycles. 6-9 June in St. Florent, Corsica. With 29 participants, and organized by **Carmen Gaina, Valentina Magni, Trine-Lise K. Gørbitz and Johannes Jakob**. Field excursion organizers: Per Terje Osmundsen and Frederic Guyedan.

Conceiving Earth Evolution and Dynamics: A seminar in honour of Trond H. Torsvik. The Academy of Science and Letters, 22 September. Organized by **Carmen Gaina.**

CEED - Conceiving Earth Evolution and Dynamics. 17-19 October in University of La Laguna, Tenerife North. With 47 participants, and organized by **Carmen Gaina, Trine-Lise K. Gørbitz, Clint Conrad, Pavel Doubrovine, Jan Inge Faleide.** Field excursion organizers: **Else-Ragnhild Neumann** and Erik Wulff-Pedersen**.** Abstract book: **Fabio Crameri.**

The 8th Nordic Paleomagnetism workshop. Hella, Iceland 30 September to 7 October. Organized by **Trond H. Torsvik,** Lauri Pesonen and Maxwell Brown.

NetherMod (XV International Workshop on Modelling of Mantle and Lithosphere Dynamics), August 27-31. Co-organized by CEED.

Advisory Board

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Centre for Earth Evolution and Dynamics (CEED) was officially opened March on 1st 2013; our research includes the dynamics of tectonic plates and Earth history, convection in the mantle, structure of the deep Earth and the origin of mantle plumes and possible connections with large scale volcanism, climate changes through geological time, mass extinctions, and research on planets from our Solar System. To ensure that our scientific vision is effectively met, 2017 activities have been carried out mainly within six research themes, each lead by a Team leader :

The Deep Earth (Team leader Reidar Trønnes)

Earth Modelling (Team leader Clint Conrad)

The Dynamic Earth (Team leader Trond H. Torsvik)

Earth Crises (Team leader Henrik Svensen)

Earth and Beyond (Team leader Stephanie Werner)

Earth Laboratory (Team leader Pavel Doubrovine)

CEED members

38 Professors, Adjunct Professors and Research Associates

23 Postdocs

15 PhD students

5 Technical-administrative staff members

9 Master students

1 Professor emerita

In total:

81 paid staff members (55 man-years

from 17 countries

*Professor **Trond H. Torsvik** with the diploma for the Fridtjof Nansen Award for Outstanding Research and Professor **Carmen Gaina with the academy membership,** Photo: Thomas B. Eckhoff/, The Norwegian Academy of Science and Letters.*

A group of CEED members outside the ZEB building at Blindern campus in February 2018

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From the Director

2017 represented for CEED “The Year of Excellence”. In the fifth year of its existence, our center is showing clear signs of scientific maturity, yet with youthful stamina.

A simple, yet powerful way to visualize our achievements, is to look at the numbers that represent our 2017 activities: **117** articles and **5** books were produced with **55** man-years. **33** papers were led by Early Career Researchers. Out of the total number of articles, **13** were published in high-impact journals (Journal Impact Factor >9). CEED was actively involved in the international scientific arena and communicated their results to the public in **183** scientific abstracts and **114** popular science articles. We have organized and co-organized **5** international workshops and meetings. CEED scientists supervised **10** Master and **15** PhD students, with **4** Master and **2** PhD theses completed in 2017.

From this vast portfolio, it is challenging to pick the outcome of greatest significance, but I would like to mention a few highlights that contribute to our core mission: “To develop an Earth model that explains how mantle processes drive plate tectonics and trigger massive volcanism and associated environmental and climate changes throughout Earth history”.

Deep Earth Evolution and Dynamics. Starting from the core-mantle boundary and from the deep-time, Deep Earth team members (Trønnes, Mohn, Løken, Eigenmann, Guren) focused their efforts to understanding the composition and evolution of the Large Low Shear Velocity Provinces (LLSVPs), and the lower-middle mantle. They found that the generation of LLSVPs above the core-mantle boundary (CMB), as well as the BEAMS (bridgmanite-enriched ancient mantle structures) structures in the middle mantle, was probably facilitated by chemical interaction between a basal magma ocean (BMO) and the proto-core in Hadean time. The contamination of large plumes rooted in the D"-zone with BEAMS material may explain the primordial He and Ne isotopic signatures of primitive basaltic lavas in large igneous provinces and oceanic islands like Iceland, Hawaii and Samoa. Other CEED teams are also contributing to the understanding of Earth´s deep structure. Heyn and Conrad from the Earth Modelling team, develop numerical models of mantle convection which indicate that an increased viscosity associated with the distinct composition of the LLSVPs helps to stabilize these structures, especially during episodes of strong deformation. A compositional viscosity contrast of about one order of magnitude would be sufficient to significantly reduce entrainment of the LLSVPs. The lower mantle has been closely scrutinized and now “vote maps” indicate with higher accuracy where subducted slabs are best detected by a myriad of global mantle tomography models (study published by Shephard-Dynamic Earth, and collaborators, including Domeier from Earth Laboratory team). These vote maps also shows that hardly any subducted material is found in the lowermost mantle (>2500 km depth) above the LLSVPs

Massive volcanism and associated environmental and climate changes. CEED studies on planetary magmatic activity through time, and possible environmental effects, are focusing on several topics: (1) Large Igneous Provinces (on land and in the oceans), (2) Volcanic continental margins, (3) Submarine volcanism (mid-ocean ridge and seamounts), (4) Mud eruptions, and (5) Volcanism on other planets. Earth Crises team members (Jones, Augland, Jerram, Planke and Svensen) together with colleagues from the Dynamic Earth team (Shephard), and international collaborators unraveled a piece of Earth History closely linked to Scandinavia, at a time before the birth of the NE Atlantic Ocean. They suggest, based on new dating of ash layers from Svalbard, that the 61.8 Ma volcanic eruptions from northern

Greenland were linked and possibly triggered by a dramatic change in plate motions that affected the entire North Atlantic and changed the paleogeography of main continents and basins. Submarine volcanism was tackled at global scale in a study by Conrad et al. (Earth Modelling) that quantifies the variability in time and space of seamount volcanism, revealing that a considerable population of seamounts erupted on older seafloor (60 million years and older), a finding which will change our view on how and where volcanoes are formed. A puzzling inverse correlation between ultra-slow spreading rates and volcanic activity vigor has been described for the Artic mid-ocean ridge by Gaina and international colleagues who have described for the first time a number of volcanoes in and around the deepest valley of the Arctic ridge. A remarkable pan-CEED study published in 2017, combined the expertise of researchers from two teams (Earth Laboratory: Domeier and Doubrovine and Dynamic Earth: Jakob, Gaina, Torsvik) for tackling the origin of the Hawaiian-Emperor volcanic chain dramatic change that occurred about 50 million years ago. The study looked into Earth´s interior, but also analyzed in-situ oceanic crust and stranded terranes for finding the culprit of the big event that changed the life of the Pacific plate. They concluded that the collision between a volcanic mountain chain existent in the Pacific and the northeastern margin of Asia has triggered a series of events that culminated with a change in the Pacific plate direction.

Mars Climate Change. New CEED research directions are gradually making headlines. A good example is the Horizon2020 project Planetary Terrestrial Analogues Library (PTAL) led by Werner (Earth and Beyond) which aims to determine mineral alteration pathways for natural and artificial terrestrial analogue materials under well-defined and controlled experimental conditions. For better constraining the geochemical aspect of habitable conditions on Mars, Earth and Beyond team members (Viennet and Bultel) and their national and international collaborators, built a new experimental setting to mimic Martian weathering profiles and concluded that surface water caused alteration of the rocks and required a different, warmer climate than on today´s Mars.

The next five years. The time we spent on preparing the mid-term evaluation was a time of reflection, where we had to carefully asses the first four years of our activities. But even before CEED received its official evaluation results, we knew that our efforts started to bear fruits. In 2017 only, CEED published 13 papers in high-impact journals, five of them led by CEED Early Career Researchers. Lead authors of Domeier et al. 2017 (Science Advances), Shephard et al. 2017 (Scientific Reports), and Jones et al. 2017 (Scientific Reports) were also successful in raising research funds to pursue their own scientific dreams (Domeier and Jones are the recipients of Young and Talented Research grants from the Research Council of Norway in 2015 and 2016 respectively, whereas Shephard received a VISTA grant from the Academy of Science and Letters in 2016).

CEED is ready to start the second half of its scientific journey. In November 2017 we've got news from the Research Council of Norway that the mid-term evaluation international committee found our centre of **excellent quality**, or in the committee's words: "Overall, the scientific outputs are excellent and together represent a substantial body of creative, innovative, high-impact work." We started in 2013 with less than 30 scientists; by now we have more than doubled our staff, but most importantly, we have a number of very enthusiastic and talented young researchers trained in CEED's spirit who will successfully carry the torch further, as they brilliantly already demonstrated. With this momentum, I am looking forward to more synergy between researchers at CEED, and with colleagues from Norway and abroad that will creatively harvest CEED´s knowledge for identifying and tackling new and exciting scientific venues.

2017 papers in high impact journals

CEED researcher, CEED young researcher*

Ashwal, L. D., Wiedenbeck, M., and Torsvik, T. H., 2017, Archaean zircons in Miocene oceanic hotspot rocks establish ancient continental crust beneath Mauritius, **Nature Communications**, v. 8.

Crameri, F.*, 2017, Planetary Tectonics Sinking Plates on Venus, **Nature Geoscience**, v. 10, no. 5, p. 330-331.

Dangendorf, S., Marcos, M., Wöppelmann, G., Conrad, C. P., Frederikse, T., and Riva, R., 2017, Reassessment of 20th century global mean sea level rise, **Proceedings of the National Academy of Sciences of the United States of America**, v. 114, no. 23, p. 5946-5951.

Domeier, M.*, Shephard, G. E.*, Jakob, J.J.*, Gaina, C., Doubrovine, P. V., and Torsvik, T. H., 2017, Intraoceanic subduction spanned the Pacific in the Late Cretaceous–Paleocene, **Science Advances**, 3: eaao2303.

Dzene, L., Ferrage, E., Viennet, J. C.*, Tertre, E., and Hubert, F., 2017, Crystal structure control of aluminized clay minerals on the mobility of caesium in contaminated soil environments, **Scientific Reports**, v. 7.

Jones, M. T.*, Augland, L. E.*, Shephard, G. E.*, Burgess, S. D., Eliassen, G. T.*, Jochmann, M. M., Friis, B., Jerram, D. A., Planke, S., and Svensen, H. H., 2017, Constraining shifts in North Atlantic plate motions during the Palaeocene by U-Pb dating of Svalbard tephra layers, **Scientific Reports**, v. 7, no. 1.

Magni, V.*, 2017, Crustal recycling evolution, **Nature Geoscience**, v. 10, no. 9, p. 623-624.

Naliboff, J. B., Buiter, S. J. H., Péron-Pinvidic, G., Osmundsen, P. T., and Tetreault, J., 2017, Complex fault interaction controls continental rifting, **Nature Communications**, v. 8, no. 1.

Rabanus-Wallace, M. T., Wooller, M. J., Zazula, G. D., Shute, E., Jahren, A. H., Kosintsev, P., Burns, J. A., Breen, J., Llamas, B., and Cooper, A., 2017, Megafaunal isotopes reveal role of increased moisture on rangeland during late Pleistocene extinctions, **Nature Ecology and Evolution**, v. 1, no. 5.

Shephard, G. E.*, Matthews, K. J., Hosseini, K., and Domeier, M.*, 2017, On the consistency of seismically imaged lower mantle slabs, **Scientific Reports**, v. 7, no. 1.

Smirnov, A. V., Kulakov, E. V.*, Foucher, M. S., and Bristol, K. E., 2017, Intrinsic paleointensity bias and the long-term history of the geodynamo, **Science Advances**, v. 3, no. 2.

Torsvik, T. H., and Domeier, M.*, 2017, Correspondence: Numerical modelling of the PERM anomaly and the Emeishan large igneous province, **Nature Communications**, v. 8, no. 1.

Torsvik, T. H., Doubrovine, P. V., Steinberger, B., Gaina, C., Spakman, W., and Domeier, M.*, 2017, Pacific plate motion change caused the Hawaiian-Emperor Bend, **Nature Communications**, v. 8.

The Central Basin, Svalbard. *Since the formation of the sedimentary sequence in the Tertiary, this area has been uplifted and then eroded. Rocks that were formed in shallow seas now form high points cut by deep fjords and glaciers. Photo: Morgan Jones*

1. Team Deep Earth: Materials, structure and dynamics

During the first five-year period of CEED, the Deep Earth group has made a focussed attempt to decipher the structure and dynamics of the lower mantle. In 2017 we made a significant leap in our perception of deep Earth and planetary origin, evolution and dynamics (Trønnes et al. in review). The generation of large low S-wave velocity provinces (LLSVPs) with elevated viscosity, bulk modulus and density, located directly above the core-mantle boundary (CMB), as well as neutrally buoyant and convectively aggregated and stabilised MgSiO3-dominated bridgmanitic domains in the middle of the lower mantle, is probably facilitated by chemical interaction between the basal magma ocean (BMO) and the protocore. Although such protocore-BMO exchange could occur in both of the two largest terrestrial planets, the rapid rotation and larger heliocentric distance of the Earth may explain the Earth-Venus dichotomy in terms of convective and tectonic style. Most of our efforts in 2017 were somehow related to this theme.

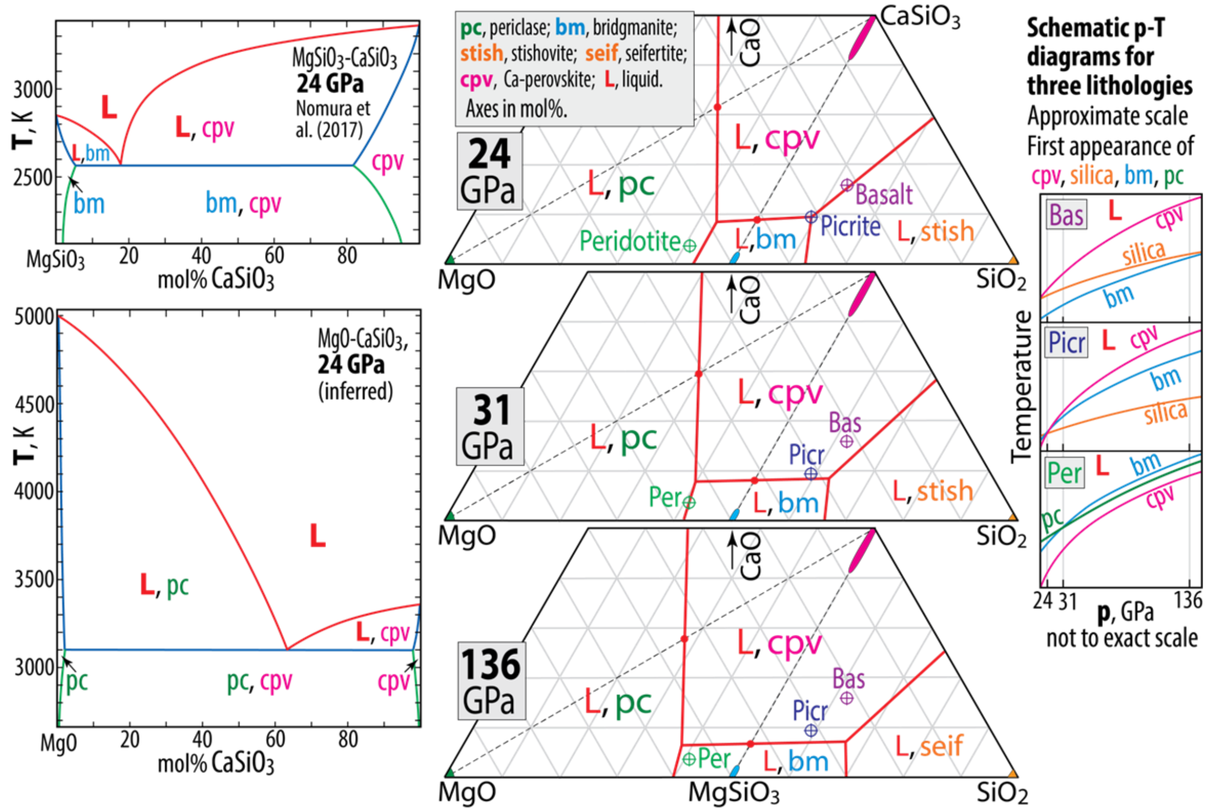
Melting relation in the system CaO-MgO-SiO2 (CMS)

In June 2017, M.A. Baron completed her PhD degree with the thesis "Experimental constraints on Earth's lower mantle melting and core formation" and M.G. Guren her MSc degree with a thesis on "Ab initio molecular dynamics simulations of melting phase relations in the system CaO-MgO-SiO2 at pressures of the Earth's lower mantle". Our experimental determination of the melting curves for the periclase-bridgmanite (pc-bm) and bm-silica eutectic compositions on the binary MS join (Baron et al. 2017) was based on the original location of the these eutectics (Liebske and Frost 2012; de Koker et al. 2013). A natural next step would be to determine directly the location of the cotectic curves and ternary eutectics in the CMS system at pressures beyond 24 GPa. This is challenging, both experimentally and theoretically, and our immediate approach is to provide indirect constraints on the ternary melting relations by establishing the melting curves of the end member components, Ca-perovskite (Guren et al. unpubl.), periclase and bridgmanite (Guren 2017). The CMS system captures about 90 and 70% of the compositions of the two dominating lithologies in the Earth's mantle: peridotite (about 93% of the mantle) and basalt (about 7%). Therefore, these melting relations in the lower mantle pressure range, presented in preliminary form in Figure 1.1, provide fundamental constraints on the earliest magma ocean differentiation and early evolution of the mantle.

Figure 1.1 (right) Melting phase relations in the system CaO-MgO-SiO2 (CMS), compiled from various sources referenced in Guren et al. (unpubl.) and Trønnes et al. (in review). Left column: Binary systems MgSiO3-CaSiO3 and MgO-CaSiO3 at 24 GPa. Middle panel: Ternary system CMS at 24, 31 and 136 GPa. The solid solution ranges of bm and cpv along the MgSiO3-CaSiO3 join are those of Nomura et al. (2017), shown in he left column. The cotectic boundaries are constrained by experimental and theoretical results on the MS join (Liebske & Frost, 2012; de Koker et al. 2013), and the phase relations in natural peridotites and basalts (refrenced in Trønnes et al. in review). Right column: Schematic p-T-diagrams for the basalt, picrite and peridotite compositions shown on the ternary CMS system diagrams.

Diffusion rate of He and Ne in bridgmanite and ferropericlase

We have continued and expanded our ab initio molecular dynamics simulations of diffusion rates for He and Ne in bm and ferropericlase (fp) subsequent to the completion of an MSc degree in Dec. 2016 (K.R. Eigenmann). The results show that the diffusion rates in the two minerals are similar and relatively high. The implication is that neutrally buoyant and refractory domains with a MgSiO3-dominated bridgmanitic lithology and high viscosity, formed and stabilised by convective aggregation in the 1600-2200 km depth range, would become charged and possibly even saturated with "primordial" He and Ne on time scales ranging from 1-6 minutes (crystals growing directly from the BMO magma) to 50-300 million years (deep melting residues) during the Hadean. At the same time, the diffusion rates are insufficient for significant ^{4}He-dilution in such domains with diameters exceeding 10 km, during the lower temperature regimes of the Archean, Proterozoic and Phanerozoic. The convective aggregation of high-viscosity material, resulting in large "blobs" (Becker et al. 1999) or BEAMS (bridgmanite-enriched ancient mantle structures, Ballmer et al. 2017) appears to be a universal outcome of convection modelling. The entrainment of blob or BEAMS material into large plumes rooted in the D"-zone can, in our view, most easily explain the primordial He and Ne isotopic signatures of primitive basaltic lavas in large igneous provinces and oceanic islands like Iceland, Hawaii and Samoa (Figure 1.2. Trønnes et al. unpubl.)



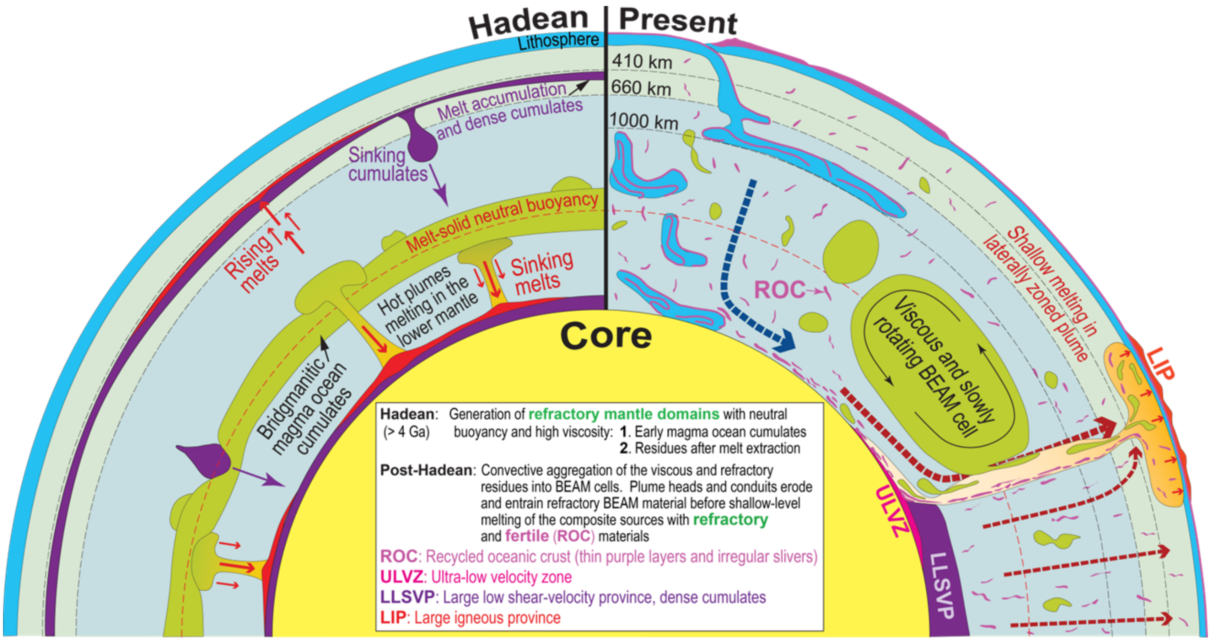


Figure 1.2. Schematic cross-sections of the Earth immediately after the Hadean Basal Magma Ocean (BMO) solidification (left) and the present Earth (right). The neutrally buoyant refractory and bridgmanitic lithologies in the 1600-2200 km depth range with very low concentrations of U and Th will be favourable reservoirs for He and Ne with primordial isotopic composition. Such refractory domains in the central parts of the lower mantle will have sufficiently high viscosity to resist convective shearing and mixing with the surrounding mantle, but may be sampled by the largest and most vigorous plumes. (Trønnes et al. unpubl.)

Partitioning of the $FeSiO_3$, $FeAlO_3$ and Al_2O_3 components between bridgmanite and post-bridgmanite

This ab initio atomistic simulation project, started already in 2013, was easily completed for the $MgSiO_3$-$FeSiO_3$ system. The low energy differences between bm and post-bm (pbm) in the systems $MgSiO_3$-$FeAlO_3$ and $MgSiO_3$-Al_2O_3, however, have required extensive computational efforts, which have also prevented other groups from successfully tackling these systems. We have repeatedly revised and adjusted our phase diagrams (Figure 1.3). The computational efforts have also clarified additional issues, including site occupancy and ferric iron spin state (e.g. Mohn & Trønnes 2016) and Fe-Al site ordering and electrical conductivity of bm and pbm in the system $MgSiO_3$-$FeAlO_3$. We have also determined the thermoelastic properties of the solid solutions in the systems $MgSiO_3$-$FeSiO_3$, $MgSiO_3$-$FeAlO_3$ and $MgSiO_3$-Al_2O_3, relevant for peridotitic and basaltic lithologies in the Earth's mantle. Our results will put tighter constraints on the structure, as well as the thermo-elastic and electrical properties of the lowermost mantle. The high-temperature LLSVPs may not contain pbm, even if the phase loops in the systems $MgSiO_3$-$FeSiO_3$ and $MgSiO_3$-$FeAlO_3$ decrease in pressure with increasing proportions of the $FeSiO_3$ and $FeAlO_3$ components. This tentative conclusion is based on the large positive dp/dT-slope of the bm to pbm phase transition and the relatively flat (relatively p-insensitive) phase loop in the system $MgSiO_3$-$FeAlO_3$, combined with a large $FeAlO_3$/$FeSiO_3$ ratio in bm crystallised from the BMO.

Partitioning of Al and mineral physics of β-stishovite and seifertite in the system SiO_2-Al_2O_3

An important outcome of the ab initio atomistic computations performed by A. Løken is the determination of a lower dp/dT-slope (4.75 MPa/K) of the β-stishovite to seifertite transition in pure SiO_2, compared to the study of Murakami et al. (2003), with the implication that seifertite is stabilised about 460 km above the CMB and throughout the entire p-T range of the outer core. In spite of the moderate density increase of the transition in pure SiO_2, the lighter cation Al^{3+} partitions nito the high-pressure phase seifertite. This excludes the O-vacancy substitution mechanism $SiO_2 \leftrightarrow AlO_{1.5}$, because this leads to a density decrease of 34 % (per replaced Si cation). The presence of available, but unfilled octahedral (interstitial) sites, however, allows two substitution mechanisms for Al in which the charge balance is restored by the incorporation of additional Al or Si into the interstitial sites: $3Si \leftrightarrow 3Al + Al^{interstitial}$ and $4Si \leftrightarrow 4Al + Si^{interstitial}$. These two mechanisms are both favourable, yielding density increases of 21.1% (per replaced Si cation). It appears that the mechanisms involving $Al^{interstitial}$ and $Si^{interstitial}$ predominate in β-stishovite and seifertite, respectively.

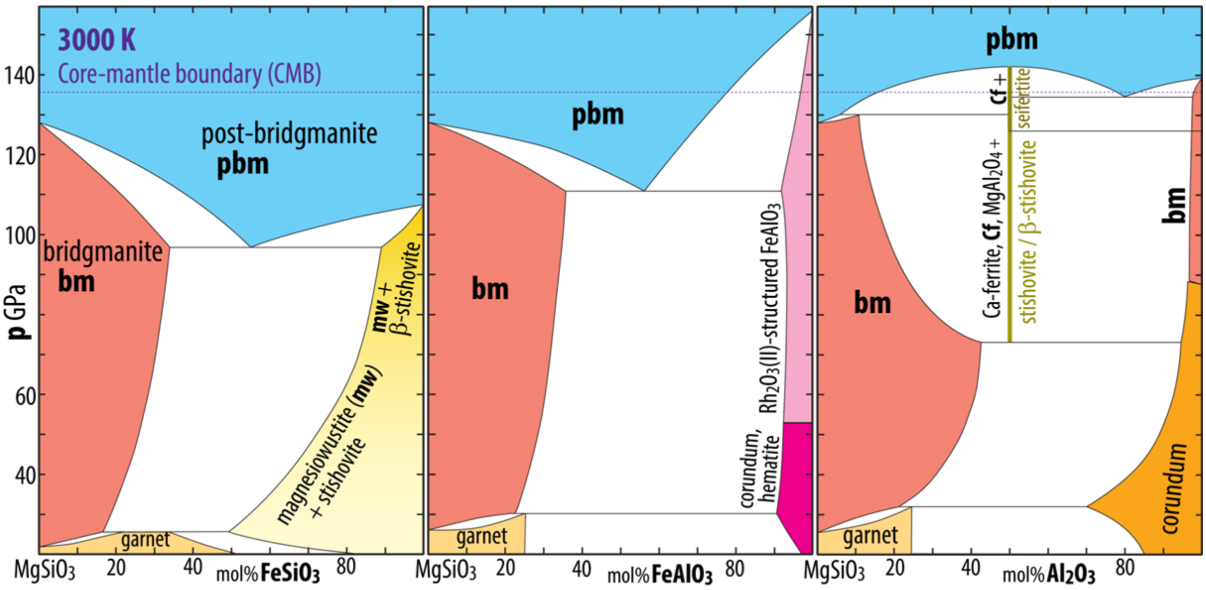


Figure 1.3. Phase relations in the systems $MgSiO_3$-$FeSiO_3$, $MgSiO_3$-$FeAlO_3$ and $MgSiO_3$-Al_2O_3 at 20-135 GPa and 3000 K compiled largely from Stixrude & Lithgow-Bertelloni (2011). The bm-pbm phase loops are from Mohn & Trønnes (unpubl.)

Activities in seismology

Two main activities were completed in 2017 and two new were started. Seismic tomography is a key tool to map the interior of the Earth, but this concept encompasses many very different techniques. We have worked on one aspect of this that involves the use of the ellipticity of Rayleigh waves to infer the seismic properties and the structure beneath and in the vicinity of seismic stations. This is particularly useful to map sedimentary basins, the crust and the upper lithosphere. Maupin (2017, Figure 1.4; Geophys. J. Int.) developed the mathematical functions that relate the 3D properties of the structure to this observable.

Slagstad et al. (2018, Terra Nova) worked on the interpretation of a seismic low-velocity anomaly detected in the lithosphere in southern Norway. We propose that enrichment in radioactive elements in the wedge of a Sveconorwegian subduction zone emplaced about 1 Gy ago can still contribute significantly to present-day elevated temperatures, and thereby to low seismic velocities.

The two new activites are related to tomography of southeast China, in particular the structure of the crust, using ambient noise, and to the analysis of seismic sources in glaciers at Svalbard. In addition, we have been active in the infrastructure EPOS project (www.epos-no.org), which will contribute to better monitoring of the Arctic regions and improved exchange of data for multidisciplinary research.

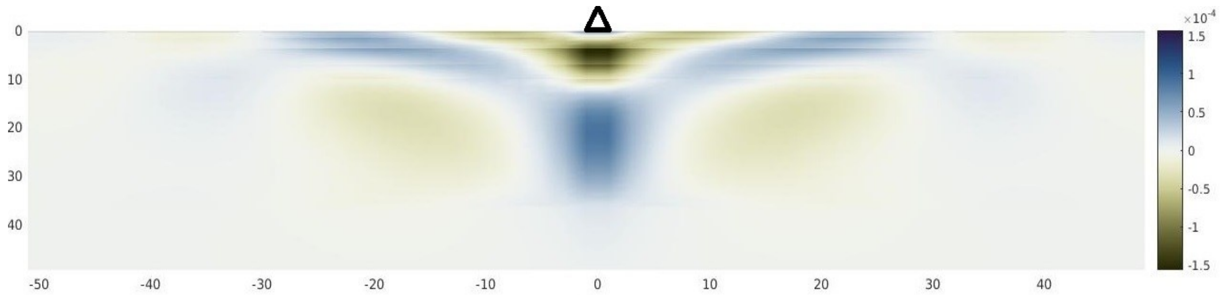


Figure 1.4. Sensitivity of the Rayleigh wave ellipticity at 20s period to changes in the S-wave velocity at a function of their depth and horizontal distance from the seismometer (in km). The seismometer is located at the surface, as indicated by the black triangle, in a seismic model of the Po valley.

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The Earth Modelling Team employs a variety of modelling techniques to understand the geodynamics of Earth's lithosphere and mantle, with a goal toward deciphering the relationship between the evolution of the mantle and plate tectonics. In 2017 the group was active in a variety of projects involving the impact of subduction on surface topography, the factors governing the stability of the LLSVP zones at the base of the mantle, the role of subducting water on long term sea level change, the impact of viscosity anisotropy on plate motions, and the distribution of seamounts within the ocean basins. In addition, a reassessment of 20th century global mean sea level, which included solid Earth deformations, was published in the prestigious journal PNAS.

CEED's Earth Modelling Team grew significantly during 2017, and has been able to broaden the scope of its activities. We are now developing models of earth processes operating throughout the entire mantle, and across timescales ranging from billions of years to the past century. Below is a brief synopsis of our most important 2017 activities. We are looking forward to more exciting results coming in 2018!

Subduction and Surface Topography

The horizontal tectonics of oceanic plates, which seem to be unique to Earth (Crameri, 2017a), additionally cause significant vertical deformation of Earth's surface. This is especially true for collisional plate boundaries, which typically feature a fore-bulge, a deep trench, an island-arc, and a back-arc depression. Through an extensive numerical-modelling study, postdoc Fabio Crameri quantified the individual impact of the major subduction parameters on each of these regional morphologies (Crameri et al., 2017). This study sheds crucial new light on the important interaction of the mantle with the surface. Building on this work using state-of-the-art numerical modelling and truly scientific visualisation (Crameri 2017b), postdoc Fabio Crameri further unravelled the cause of an enigmatic observation: during Earth's history many continents have been subject to abrupt, continent-wide tilting. The numerical models show that tilts of more than 0.03° typically occur in less than 10 Myr once a sinking plate crosses the upper-mantle transition

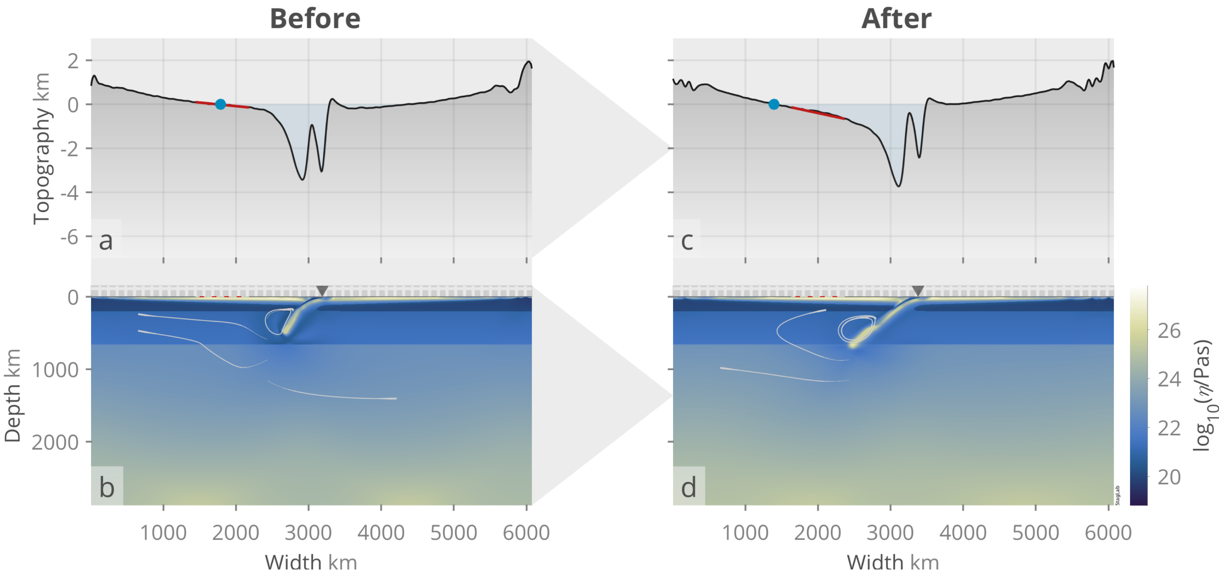

Figure 2.1. Comparison of surface topography (top) and mantle flow pattern (bottom) both before (left) and after (right) the interaction of the slab with the transition-zone. The surface topography (a,c) is marked with indicators for upper-plate tilt (red bar) and inundation (blue dot). Mantle flow (b,d) is shown by white stream lines indicating flow direction within a variable viscosity mantle (background colors show effective viscosity).

zone (Crameri & Lithgow-Bertelloni 2017). This dynamic interaction sets parts of the higher viscosity lower mantle abruptly into motion and activates a large-scale mantle return flow cell (Figure 2.1). This induces a significant horizontal pressure gradient at the base of the upper plate that is strong enough to tilt the plate over a continent-wide area, leading to continental flooding.

Stability of the LLSVPs

The large low shear velocity provinces (LLSVPs) are a prominent feature in the lowermost mantle, but their survival time and stability are not well constrained. To analyse the conditions for survival of dense material at the bottom of the mantle, PhD candidate Björn Heyn developed numerical models of mantle convection that employ a range of viscosity profiles. The results indicate that an increased viscosity associated with the distinct composition of the LLSVPs helps to stabilize these structures, especially during episodes of strong deformation. A compositional viscosity contrast η_C of about one order of magnitude is sufficient to significantly reduce entrainment of the LLSVPs into the rest of the mantle, although entrainment rates also depend on the thermal viscosity contrast $\eta_{\Delta T}$ and the excess density B (Figure 2.2).

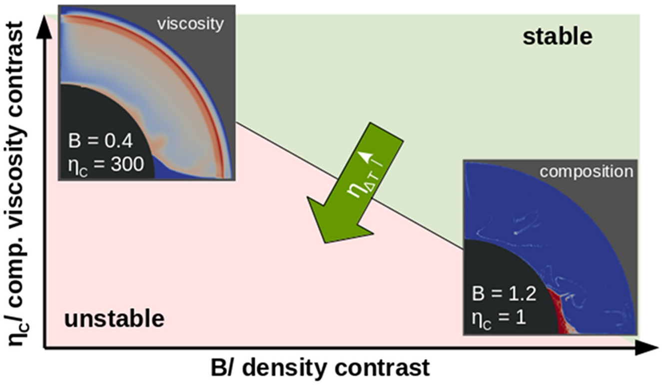

Figure 2.2. Stability fields of thermochemical piles as a function of density contrast B and compositional viscosity contrast η_C. We found that a higher thermal viscosity contrast $\eta_{\Delta T}$ expands the stable field (light green) towards lower B and/or η_C. Insets show examples of the viscosity and composition

Deep Water Recycling and Sea Level Change

Subducting slabs carry large volumes of water into Earth's interior. Even though most of this water returns to Earth's surface through arc volcanism, a significant fraction is carried deeper into the mantle. Previous modeling studies have found that the subduction water flux is well correlated with both the age and the velocity of the subducting plate, while the water outgassed at ridges is thought to be proportional to the spreading rate. By applying ocean-mantle water flux parameterizations to tectonic reconstructions of past ridges and subduction zones, PhD candidate Krister Karlsen developed models for the total water flux between the ocean and the mantle for the last 230 Ma. He found that imbalanced water exchange between the oceans and the mantle could have removed enough seawater to cause a sea level drop of 50-200 m since the Mesozoic (Figure 2.3). This suggests that water loss to the mantle may be a significant contributor to long-term sea level change.

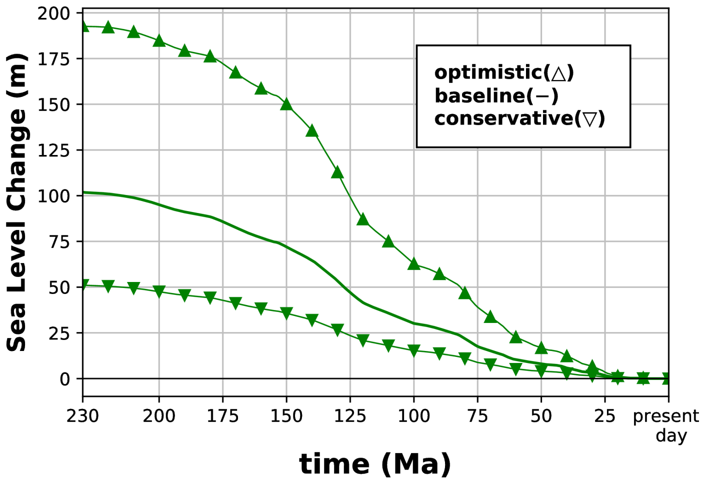

Figure 2.3. Sea level change based on estimated ocean-mantle water fluxes for three parameterizations of the subduction water flux.

Anisotropic Viscosity and Plate Motions

Olivine, the primary mineral in the upper mantle, is anisotropic in its mechanical properties. As a result, significant upper mantle shearing causes olivine crystals to form a preferred orientation that we can observe, for example, using seismic wave propagation. The alignment of olivine grains also results in anisotropic viscous behavior that may result in significant changes in effective viscosity as the direction of flow changes. Postdoctoral researcher Agnes Kiraly is studying the effect of viscosity anisotropy in different geodynamic settings using numerical models of anisotropic texture development that are constrained by laboratory measurements. Preliminary numerical tests show that simple shear produces a rock texture for which viscosity can be an order of magnitude different for shear occurring in different directions across the fabric (Figure 2.4). Development of such textures in the asthenosphere may therefore offer significant resistance to changes in the plate motion direction. In contrast, the anisotropic viscosity of the upper mantle may be especially conducive to shear on a vertical plane, which may promote subduction initiation. More generally, textured rocks in the asthenosphere, and the anisotropic viscosity that they induce, should significantly influence the geodynamics of plate motions and their interaction with the convecting mantle.

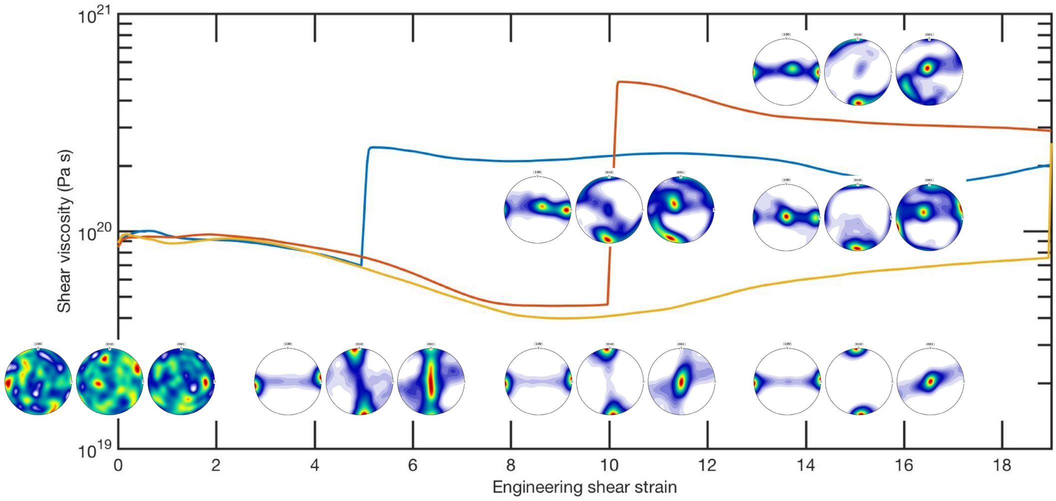

Figure 2.4. Viscosity profiles of olivine aggregates formed from accumulated shear strain (x-axis) for three model runs for which the direction of applied shear is changed by 90° after a strain of 5 (blue), 10 (orange), or 19 (yellow). The shear viscosity increases after each change because of misalignment between the shear direction and the rock texture, shown here by stereonet insets at strains of 0 and 5 (same for all models), 10 (separate for the blue curve), and 15 (separate for all models).

Distribution of Seamounts

More than 24,000 seamounts have been discovered beneath the Earth's oceans and now we have a nearly complete catalog of seamounts taller than 1 km. Team Leader Clint Conrad examined their statistics and found that accumulated seamount volume is relatively constant for seafloor younger than 60 Myr old, but is larger for older seafloor. This suggests that many seamounts are formed on mid-ocean ridge flanks, and that another population of seamounts is erupted after the seafloor ages beyond about 60 Myr (Figure 2.5). The seamount volumes also show that the Pacific basin has an unusually high volume of seamounts erupted on Cretaceous-age seafloor, which suggests heightened seamount volcanism during that time (Conrad et al., 2017).

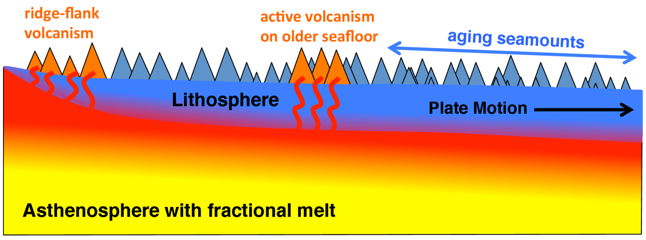

Figure 2.5. Model for seamount emplacement based on the observed seamount distribution.

20th Century Sea Level Reconstruction

Satellite observations show that sea level is currently rising faster than 3 mm per year, but the rate of sea level rise prior to the satellite era (pre-1992) is only constrained by tide gauge observations at a small number of seaports around the world. Team Leader Clint Conrad was part of group that developed a new reconstruction of 20th century sea level by incorporating solid earth deformations that affect the tide gauge measurements. This reconstruction, which was published in the high profile journal PNAS (Dangendorf et al., 2017), shows that sea level rise accelerated from ~1 mm/yr in the first half of the 1900s to more than 3 times that rate in the past few decades (Figure 2.6). The quantification of this acceleration may affect projections of future sea level rise that will eventually impact coastal communities in the coming century.

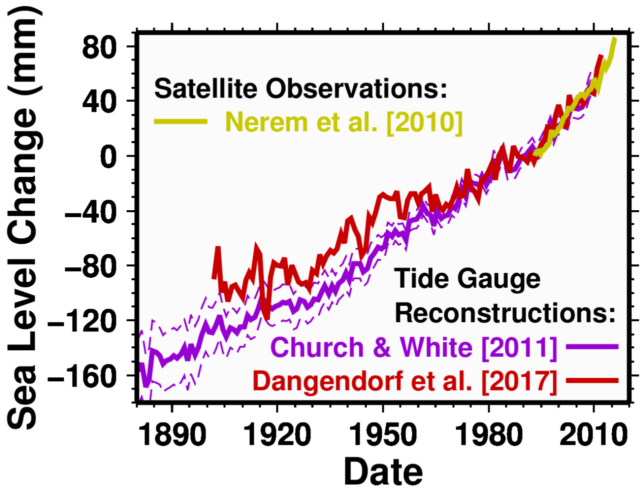

***Figure 2.6**. Reconstructions of global sea level change based on observations from satellites (yellow) and tide gauges, for which the new Dangendorf et al. (2017) study (red) suggests faster acceleration compared to previous studies (purple).*

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3. Team Dynamic Earth: Plate motions and Earth history

The Dynamic Earth Team explores plate motions and Earth history in the framework of Plate Tectonics and the Wilson Cycle. The Team is divided into three working groups (WGs), one focussing on passive margins and basin evolution (WG1: Integrated Basin and Lithospheric Studies), a second addressing continents adrift, oceanic basin formation and climate (WG2: Oceanic Basins and Climate Changes) whilst the third working group focus on subduction and collision but also old margins now variable preserved in the mountain belts (WG3: Margins and orogeny). Collectively these WGs cover the entire Wilson Cycle from Wilson kick-off through continents adrift to subduction and terminal collision. The Dynamic Earth Team strongly collaborates with the other CEED Teams and international collaborators in exploring links between plate tectonics, intra-plate volcanism and deep Earth dynamics, and in exposing lost continents in the ocean basins (e.g., Ashwal et al. 2017). In 2017, Dynamic Earth members and their collaborators published around 50 articles. Torsvik and Cocks also published a book in 2017 ("Earth History and Palaeogeography") which was awarded the Prose Award for the best book in the Earth Sciences (Association of American Publishers).

Working Group 1: Integrated Basin and Lithospheric Studies

In 2017, this working group and their collaborators published 16 papers mainly focused on the NE Atlantic continental margins, the Barents Sea and the High Arctic. In these studies, structures and processes at lithospheric, crustal and basin scales are linked to constrain basin/margin evolution. Our published results in 2017 are divided in three main areas/topics:

North-East Atlantic margins

We have published new papers covering all three segments of the Norwegian margin, the Møre, Vøring and Lofoten margins respectively.

The Theissen-Krah et al. (2017) paper explored the stretching factors, resulting extension, and structural evolution of the Møre segment on the mid-Norwegian continental margin. Based on the interpretation of new and reprocessed high-quality seismic, they presented updated structural maps of the Møre margin that show very thick post-rift sediments in the central Møre Basin and extensive sill intrusion into the Cretaceous sediments. A major shift in subsidence and deposition occurred during mid-Cretaceous. A crustal transect across the Møre margin was reconstructed, and different initial crustal configurations and rifting events were tested and compared. Extension was estimated to ~188 ± 28 km along the transect for initial crustal thickness varying between 30 and 40 km. Seismic interpretation in combination with structural reconstruction modelling does not support the lower crustal bodies as exhumed and serpentinised mantle.

The Abdelmalak et al. (2017) paper follows up a number of recent papers from our group focusing on breakup-related magmatism at the mid-Norwegian margin. This time focus is on key observations made in deep seismic reflection and refraction data across the Vøring margin. In particular, the new seismic reflection data allow identification of high-amplitude and laterally continuous reflections in the middle and lower crust, locally referred to as the T-Reflection. It seems to be connected to deep sill networks (Figure 3.1). Spatial correlation between filtered positive Bouguer gravity anomalies and the deep dome-shaped reflections indicates that the latter represent a high-impedance boundary contrast associated with a high-density and high-velocity body, also detected by the deep seismic refraction data. The characteristic lower crustal body likely represents a complex mixture of pre- to syn-breakup mafic and ultramafic rocks and old high-grade metamorphic rocks. An increasing degree of melting toward the breakup axis is responsible for an increasing proportion of cumulates and sill intrusions in the lower crust.

The Breivik et al. (2017) paper presents a new crustal-scale transect across the Lofoten margin, from mainland Norway to the deep ocean. The extensive magmatism at the Vøring Plateau off mid-Norway died down rapidly northeastwards towards the Lofoten/Vesterålen Margin. The velocity model reveals a continental margin transitional between magma-rich and magma-poor rifting. For the first time a distinct lower crustal body typical for volcanic margins has been identified at this outer margin segment, up to 3.5 km thick and ~50 km wide. On the other hand, expected extrusive magmatism could not be clearly identified here. Strong reflections earlier interpreted as the top of extensive lavas may at least partly represent high-velocity sediments derived from the shelf, and/or fault surfaces. It appears that continental breakup took place at ~53.1 Ma, ~1 m.y. later than on the Vøring Plateau, consistent with late strong crustal extension. The low interaction between extension and magmatism indicates that mantle plume material was not present at the Lofoten Margin during initial rifting, and that the observed excess magmatism was created by late lateral transport from a nearby pool of plume material into the lithospheric rift zone at breakup time.

Barents Sea

Deep seismic refraction data across the western Barents Sea have been analyzed with focus on Caledonian structural trends and deep basin configurations. Aarseth et al. (2017) is the first paper published based on these data. Local deepening of Moho, seen both in the deep seismic refraction and reflection data, creates “root structures” that can be linked to Caledonian compressional deformation or a suture zone imprinted in the lower crust. Our model supports a separate NE-SW Caledonian trend in the central/northern Barents Sea, branching off from the northerly trending Svalbard Caledonides, implying the existence of "Barentsia" as an independent microcontinent between Laurentia and Baltica.

In collaboration with other groups/projects at the department we have also published several papers focusing on various structural elements in the SW Barents Sea, such as the Loppa High (Indrevær et al., 2017a,b), Stappen High (Blaich et al., 2017) and Fingerdju-

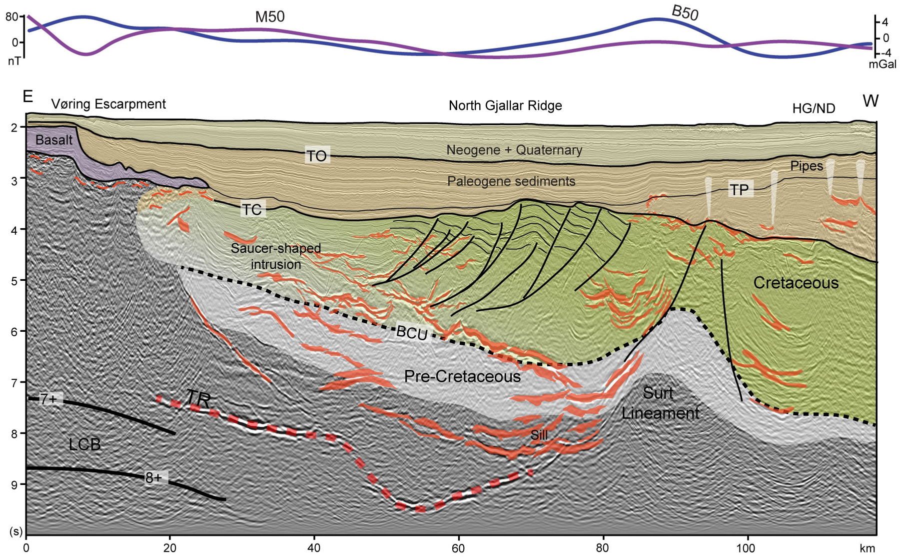

Figure 3.1 Deep sill network in the Vøring Margin, offshore mid-Norway. LCB, Lower Crustal Body (7+ km/s); TR, T-Reflection; TC, Top Cretaceous; TP, Top Paleocene; TO, Top Oligocene (Abdelmalak et al., 2017).

pet Subbasin (Serck et al., 2017).

High Arctic

The Faleide et al. (2017) paper summarizes the lithospheric structure and evolution of the wider Barents–Kara Sea region based on compilation/integration of geophysical and geological data. Regional transects are constructed at both crustal and lithospheric scales based on the available data and a regional three-dimensional model. The transects, which extend onshore and into the deep oceanic basins, are used to link deep and shallow structures and processes, as well as to link offshore and onshore areas. The study area has been affected by numerous orogenic events and at least three episodes of regional-scale magmatism forming large igneous provinces (LIPs). Within this geological framework, the basin development is integrated with regional tectonic events, and the timing, causes and implications of basin evolution are discussed. Regional uplift/subsidence events are discussed in a source-to-sink context and are related to their regional tectonic and palaeogeographical settings.

The Minakov et al. (2017) paper performs an integrated analysis of magnetic anomalies, multichannel seismic and wide-angle seismic data across an Early Cretaceous continental large igneous province in the northern Barents Sea region. High-frequency and high-amplitude magnetic anomalies in this region are spatially correlated with dykes and sills observed on-

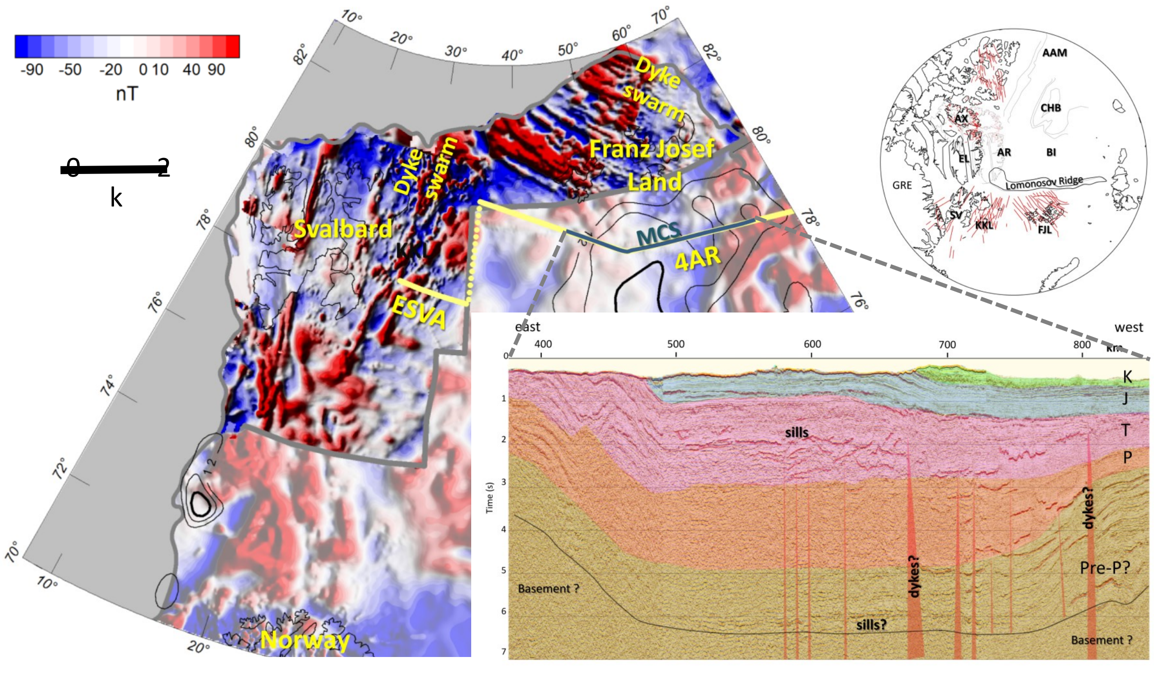

Figure 3.2 Magnetic anomalies of the Barents Sea region and a seismic line across the Early Cretaceous dyke swarm south of Franz Josef Land in the NE Barents Sea. The index map in the upper right corner show the geometry of the High Arctic large igneous province (HALIP) dyke swarms on an Early Cretaceous plate reconstruction. AX, Axel Heiberg Island; BI, Bennett Island; CHB, Chukchi Borderland; EL, Ellesmere Island; FJL, Franz Josef Land; GRE, Greenland; KKL, Kong Karls Land; SV, Svalbard. (Modified from Minakov et al., 2017).

shore (Figure 3.2). The dykes are grouped into two conjugate swarms striking oblique to the northern Barents Sea passive margin in the regions of eastern Svalbard and Franz Josef Land, respectively. The seismic reflection data show the presence of sills at different stratigraphic levels over a wide region, and these are most abundant in the East Barents Sea Basin. The crustal structure does not include magmatic underplating and shows no regional crustal thinning, suggesting a localized (dyking, channelized flow) rather than a pervasive mode of magma emplacement. A numerical model for the geometry of the dyke swarms, which match the observations, is also presented.

Collaboration

In our Arctic research we have had close collaboration within the CALE project (Circum-Arctic Lithosphere Evolution. PI V. Pease, Stockholm University), which was completed in 2017. The Faleide et al. (2017) paper was one of the contributions synthesizing CALE in a Geological Society Special Publication. A new Arctic network (NOR-R-AM, PI C. Gaina CEED) was also initiated and will be a key arena for our Arctic research in the years to come. In particular, we have further developed our collaboration with Russian partners at St Petersburg University, and three of the 2017 paper have co-authors from Russia.

We also have close collaboration with other complementary projects in the Barents Sea, in particular with ARCEx (Research Centre for Arctic Petroleum Exploration). Among the international partners, we collaborate closely with GFZ Potsdam both in the Barents Sea and the NE Atlantic.

Working Group 2: Oceanic Basins and Climate Changes

In 2017, this working group and their collaborators published 24 papers and contributed to another 4 CEED articles. Our published results are divided in three main topics:

The structure and evolution of the NE Atlantic and Arctic regions

The present day architecture of the NE Atlantic continental margins and oceanic sub-basins and their evolution through time has been documented in detail in a special volume of the Geological Society of London: "The NE Atlantic region: A reappraisal of crustal structure, tectono-stratigraphy and magmatic evolution" edited by Peron-Pinvidic et al. (including C. Gaina). The volume includes 5 papers by CEED scientists and collaborators, out of each, one article describes the morphology of the seafloor spreading domains in the NE Atlantic (Gaina et al., 2017a) as a function of changes in the far-field tectonic stresses, and another one links the observed NE Atlantic seamount-like volcanic features with the Iceland plume episodic activity combined with regional changes in relative plate motion (Gaina et al., 2017b).

The formation of the Makarov Basin, an enigmatic small basin in the Arctic Ocean, has been explained as a result of a break-up and contained seafloor spreading episode within a Large Igneous Province-the Alpha Ridge, due to a series of local adjustments triggered by changes in larger-scale plate motions in the Late Cretaceous-Paleocene time (Døssing et al., 2017).

Oceanic basin dynamics and continental collision linked to the mantle

A landmark paper published by a group of Early Career Scientists, headed by CEED young researcher G. Shepard, applied a "vote map" methodology for mapping consistent features across alternative seismic tomography models, such as subducted slabs, (Shephard et al. 2017) and was published in the high-impact journal Scientific Reports (Figure 3.3). An extension of these vote maps were used as part of Domeier et al. (2017, Science Advances), which identified sub-Pacific slabs related to the Hawaiian-Emperor Bend reorganization (see Earth Laboratory section).

The dynamics of continental collision and the fate of the subducted continental crust has been investigated in Magni et al. (2017). The numerical models of this study showed that underplating of

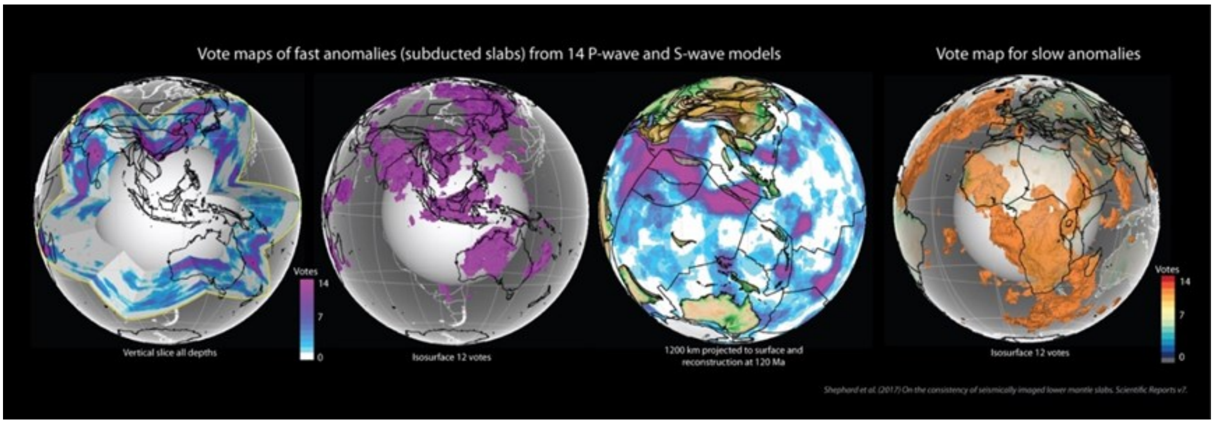

Figure 3.3 Vote maps showing subducted slabs and tectonic plates in GPlates software. The image was the December 2017 cover image for the EGU Geodynamics Division's Facebook page.

the subducted continental lithosphere can occur after slab break-off. These results have been used to explain the crustal structure and magmatic and tectonic evolution of the India-Eurasia collision zone. An overview on the different styles of continental crustal recycling and how they have changed through time, from the early Earth to present day, has been published in the Nature Geoscience News & Views by V. Magni (Magni, 2017).

Paleoclimate studies

The timing, duration, and causes for Late Jurassic-Early Cretaceous anoxia in the Barents Sea has been discussed by Georgiev et al., 2017, who showed that the Late Jurassic anoxia was likely the result of warming climate due to high atmospheric CO_2 levels from increased oceanic crust production. This study shows that an assessment of new and published Os- and Sr-isotopic data suggests that prolonged oceanic anoxia required a sustained CO_2 source from fast spreading rates and/or longer subduction zones and spreading ridges to balance large burial of carbon in voluminous Upper Jurassic and Lower Cretaceous black shales.

An on-going PhD project (PhD student E. Straume) aims to model the paleooceanography of the NE Atlantic by using realist paleo-bathymetry. We have constructed a mid-Miocene model (12 Ma) that includes detailed reconstruction of oceanic gateways, especially the NE Atlantic Ocean and the Fram Strait, where we have implemented new models considering crustal thickness, dynamic support from the Iceland Plume, and microcontinents (Figure 3.4). Preliminary results show that the Pacific Ocean was dominating the global overturning circulation, a scenario that has been previously proposed for shorter and more recent climate periods such as the last glacial maximum. In contrast, our new model results suggest that such a mode could have been a stable state in the Miocene due to a different bathymetric configuration (Straume et al., 2018).

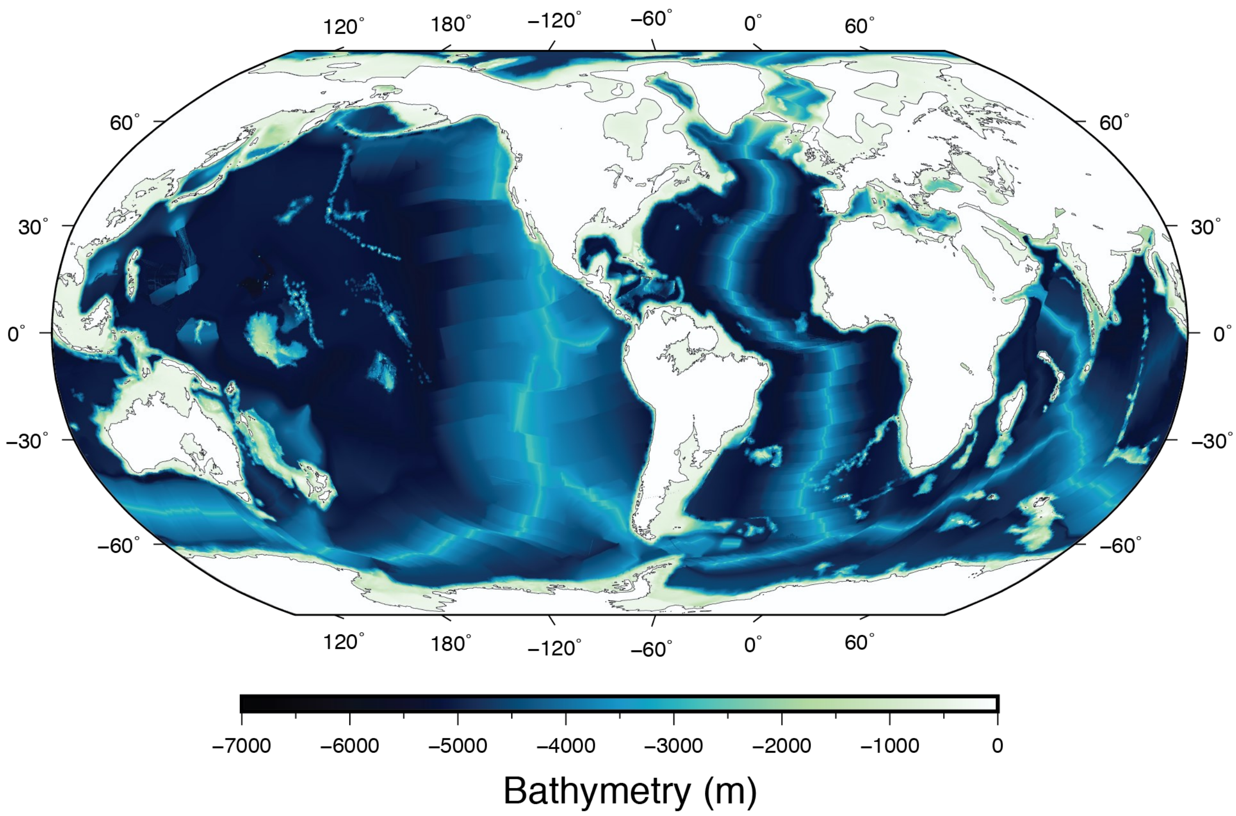

Figure 3.4. Global paleobathymetry at 12 Ma (E. Straume)

Working Group 3: Margins and Orogeny

In 2017, this working group and their collaborators published 3 papers and our research have largely been focused on unravelling the lithological and structural architecture of the pre-Caledonian margin developed along Baltica in Late Precambrian (Ediacaran) times. We have

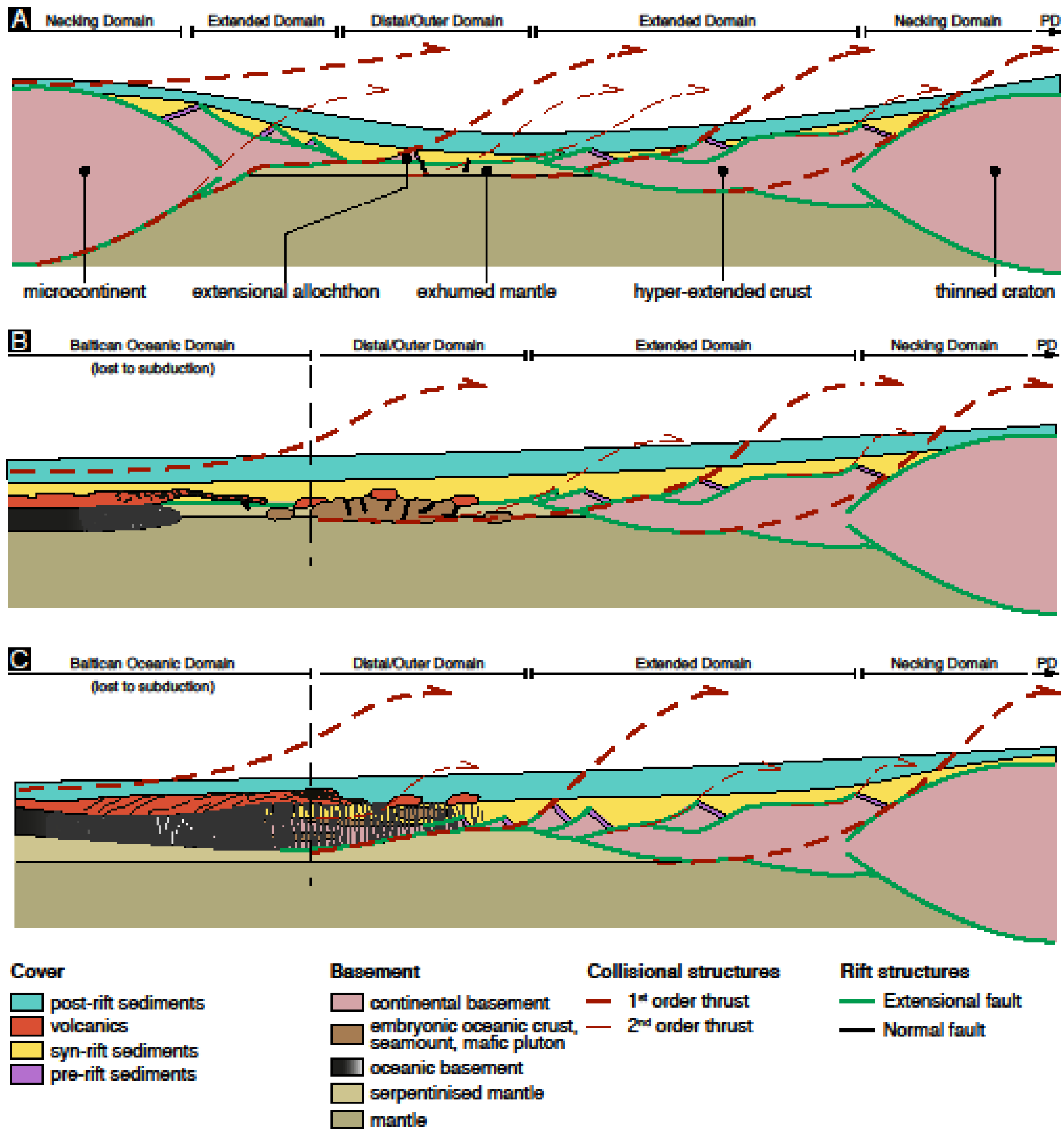

Figure 3.5. Reconstructed cross-sections along strike from the magma-poor (south) to the magma-rich (north) part of the pre-Caledonian margin of Baltica, with contractional structures dotted in red (Jakob et al., submitted). A) shows the section with the hyperextension, extensional allochthons and exhumed mantle between the Jotun microcontinent and Baltica (right). B) is a section with hyperextension w/transitional crust and incipient sea-floor spreading as exemplified by the vestiges of the margin between Lom and Røros. In C we show a section of the magma-rich margin as exemplified in the Seve unit in the North Central Caledonides, where examples of all sections, including the lower crustal body, of this margin can be studied in the field.

also used the more modern Norwegian Sea margin to study transitions between magma-rich and magma-poor sections of passive margin and to use the rift-inherited template to explain along-strike differences during inversion and formation of mountain belts. Important activities and achievements in 2017 include:

Field work and field seminars

The Tethyan passive margin evolution has been an important field analogue for our work in the Norwegian Sea and in the Caledonides. Team members have also participated in two field seminars in the eastern Swiss Alps in 2017. The field seminar w/presentations (by invitation) IMAGinING RIFTING (Andersen, Buiter) and the field trip (Jakob, Kjøll, Mohn) to study the field analogues of the Alps have been important for our work in the Caledonides where expedition-type field studies, with extensive use of helicopters were carried out in remote areas of northern Scandinavia; in Troms and northernmost Sweden and in central South Norway. These studies have concentrated on the internal structure of the pre-Caledonian magma-rich ocean-continent transition zone preserved within the Seve and Kalak Nappe Complexes in the North; and in the magma-poor to magma-rich transition in the South. The middle to lower crustal sections of the magma-rich margin that can be studied in the North are unique. A large amount of new geochemical and geochronological data has been collected and petro-physical measurements to acquire seismic velocity data from the meta-igneous and granulite facies lower crustal complexes are in progress. Likewise, field work combined with structural, geochronological and petrological has been carried out in a large area in Southern Norway, where the field studies in 2017 were concentrated on the pre-Caledonian magma-poor to magma-rich margin transition zone preserved between Lom and the boarder land to Sweden (Figure 3.5).

We anticipate to use the complete dataset (geochemistry/petrology, geochronology, metamorphic and structural history) to establish for the first time a complete model for the exposed sections across and along strike of the margin in the Scandinavian Caledonides, which now can be traced all the way to the Finnmark (Figure 3.6).

Publications

Tw**o** publications on geochronology, structure, metamorphism and stable isotope evolution of the magma-poor passive margins, in the Caledonides, which was for a large part based on the PhD work of postdoc Johannes Jakob were published in 2017. The work in progress has been presented at several meetings and workshop (NGS-winter meeting, EGU-2017, IMAGinING RIFTING, FORM-conference) and includes 15 published abstracts to oral and poster presentations.

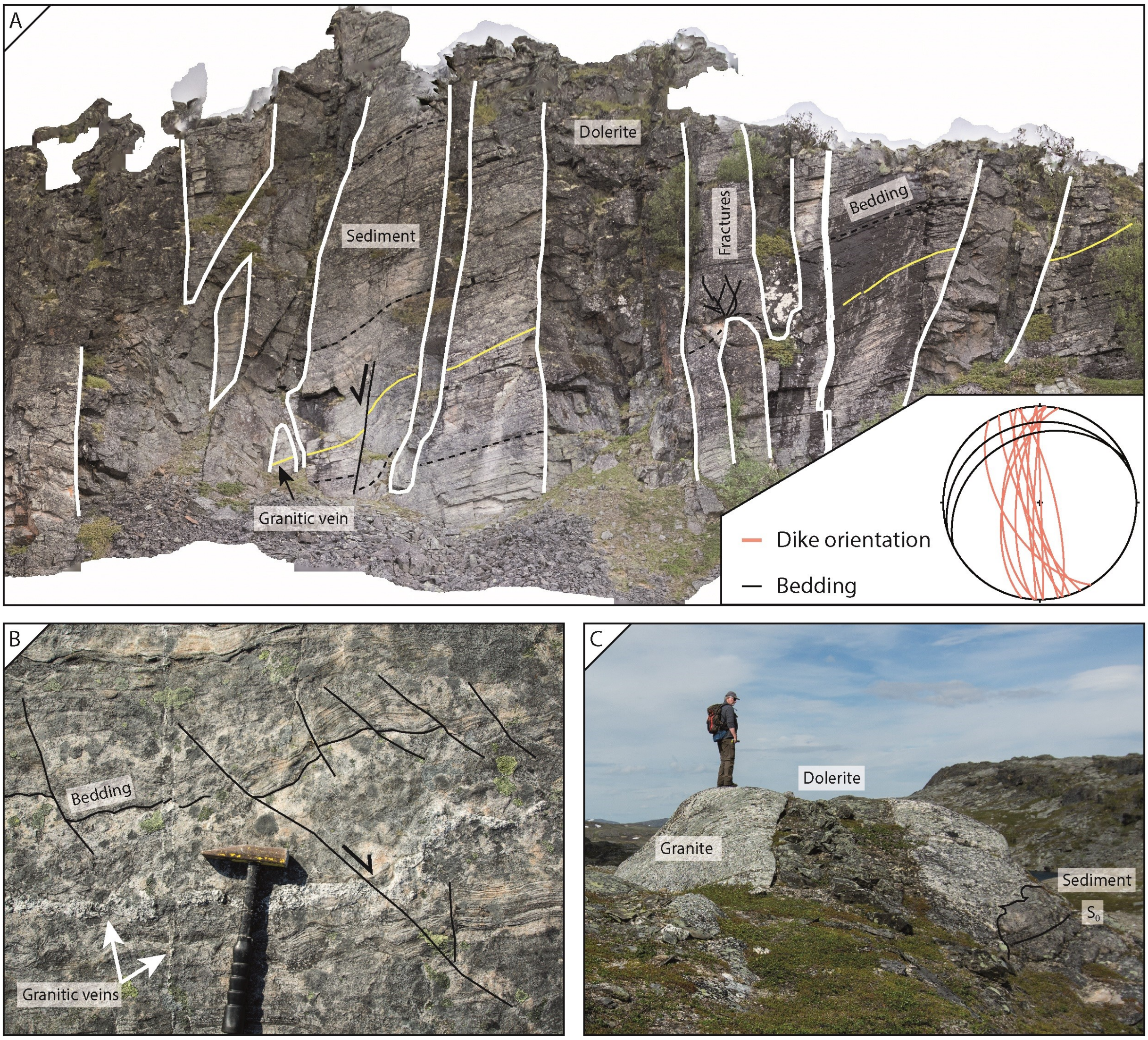

Figure 3.6. Dyke-wall rock relationships at the northernmost confirmed pre-Caledonian dyke-complex in Finnmark (Kjøll et al., submitted). A) Shows a section of well-preserved dykes dated at ~605 Ma cutting deformed and metamorphosed metasandstones. White lines show fracture systems in front of dyke tips. Stereonet shows the high-angle between foliation in the wall rocks and the steep dykes (red). B) Early layer-parallel normal faults in a migmatitic wall-rock of the dykes. C) Dolerite cutting S-type granite (~610 Ma) and metasediments, documenting the high-temperature metamorphism related to the lower crustal emplacement of the dykes (Kjøll et al., unpubl.)

Collaboration

Principal external collaborators in 2017 were Prof C. Tegner (Univ. Århus), Prof. L. Labrousse, UPMC-Paris-6, Dr. Geoffroy Mohn; Univ Cergy-Pontoise) and Dr S. Buiter NGU/CEED. Student involvement in 2017 include master students Orlando Quintela, UiO and internship student, Pierre Closset, Univ. Strasbourg. The research group hosts the NFR FRINATEK project (PI, T.B. Andersen) 'Hyperextension and passive margins' project for the period 2016 -19.

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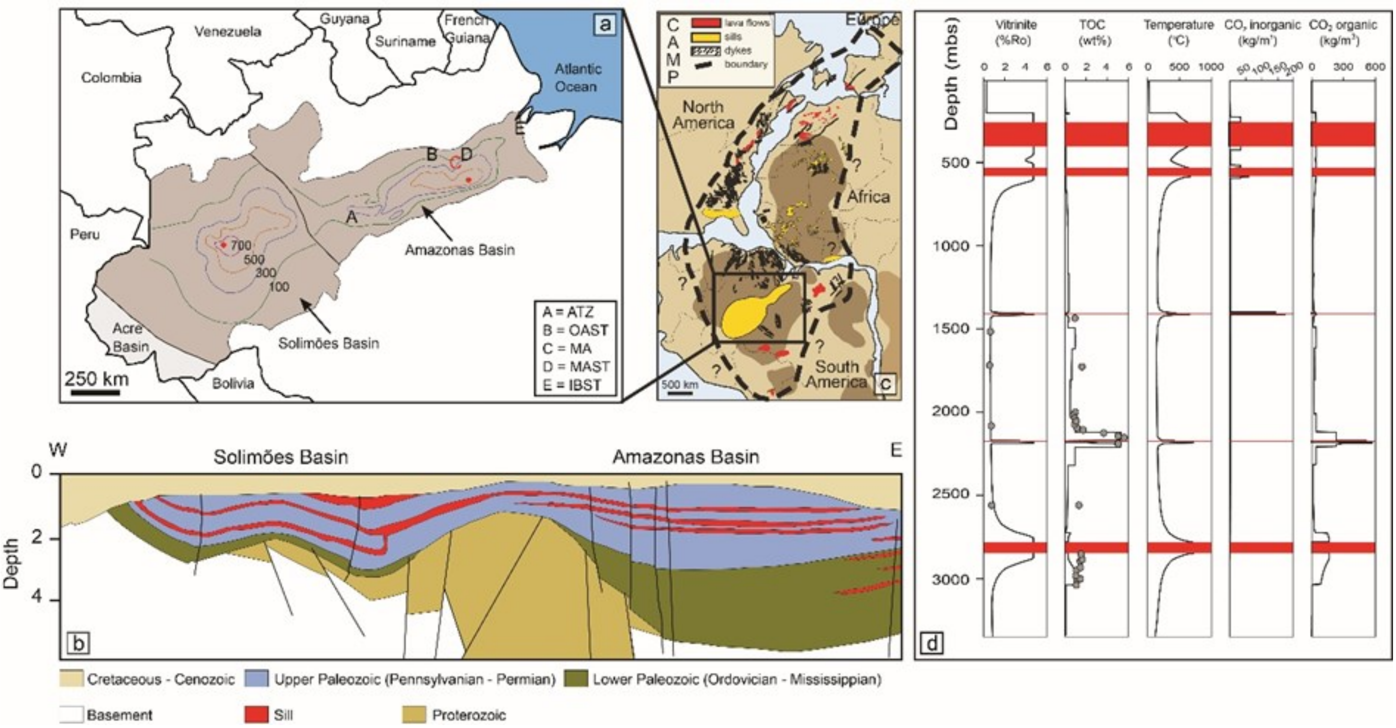
Jan Inge Faleide *receives the Norwegian Polar Research prize for 2017. The prize is awarded on Fridtjof Nansen`s birthday on the 10th of October, to a prominent Norwegian polar researcher. Photo: Faleide and the UiO Rector Svein Stølen by Carmen Gaina, CEED*

4. Team Earth`s Crises: LIPs. Mass extinctions and

In the Earth Crises group we study volcanically driven effects on the climate system and the biosphere, focussing on Large igneous provinces (LIPs). The Earth Crises mission is to investigate the role of volcanism in general, and sediment-derived gases in particular, on the history of life on Earth. Here we present a selection of the results, updates, and activities from 2017, focussing on: 1) the end-Triassic mass extinction and the CAMP LIP, 2) two published papers from Master students, 3) the LUSI eruption in Indonesia, 4) the TIMS U-Pb laboratory and the new stable isotope laboratory, and 5) the ASHLANTIC project and the Paleocene-Eocene Thermal Maximum .

The end-Triassic mass extinction and the CAMP

We have known for some time that there is a correlation between the creation of LIPs and mass extinction events. We have tested the hypothesis that widespread sills of the Central Atlantic Magmatic Province (CAMP; Marzoli et al., 2018) intruded in volatile-rich Brazilian sedimentary basins were responsible for the end-Triassic environmental and biotic crises through release of massive amounts of isotopically light carbon. Up to 20% the stratigraphy of the Amazonas and Solimões basins is composed by CAMP sills, now dated by U-Pb CA-ID-TIMS to 201.477±0.062 Ma and 201.470±0.089 Ma. The multiple borehole logs studied revealed that the sills intruded carbonate and evaporite lithologies as well as organic-rich shales and hydrocarbon reservoirs. Modeling of thermal metamorphism of these sediments, applied for the first time to the CAMP event, was performed using the CEED-developed one-dimensional (1D) numerical model, Silli 1.0 (Iyer, Svensen, Schmid, 2018), and demonstrated that contact metamorphism in the two basins could have generated up to 88,000 Gt CO_2. The results were published by PhD student T.H. Heimdal and co-authors in the journal Scientific Reports in January 2018.



Two published papers from Master students

We are proud to present two published papers from our Master students Sigurd Kjoberg and Reza Angkasa. They graduated in June 2017 and their papers were published in the AAPG journal Interpretations about a year later. Kjoberg et al (2017) presents new results from a 3D seismic cube from the Møre Basin offshore Norway, where Sigurd mapped and interpreted sills and hydrothermal vent complexes in great detail – and made an analogue sandbox model to explain his findings. Reza's paper is about the initiation of flood basalt volcanism on the Isle of Skye, Scotland, based on fieldwork and geochemical analyses.

The LUSI eruption in Indonesia

Our studies at the Lusi eruption site (Indonesia) continue with our partners in the framework of the LUSI LAB ERC project combining field-based and numerical studies. A special issue titled "*10 years of Lusi eruption: Lessons learned from multidisciplinary studies*" is entirely dedicated to the LUSI LAB activities, collecting 17 manuscripts reporting the acquired results. Ambient noise tomography results revealed impressive subsurface data from the region around the Lusi mud eruption (Fallahi et al., 2017). A vertical hydrothermal plume is present down to at least 6km below Lusi. This conduit is connected at 4.5 km depth with an elongated corridor that links with the magma chamber imaged below the neighbouring volcanic complex. New work includes interpretations of water geochemistry (Mazzini et al., 2017), and gas release from contact metamorphism at depth (Svensen et al., 2017). The reported results made headlines in international media sites such as EOS, AGU, and National Geographic Magazine.

Figure 4.2 (above). The Lusi mud eruption as seen from a drone. Adriano Mazzini is a co-author of more than 15 papers about Lusi published in 2017. Photo: Adriano Mazzini.

Figure 4.1 (left; a) Cumulative sill thickness distribution is outlined within the Solimões and Amazonas sedimentary basins in northern Brazil. (b) Schematic cross-section of the basins shows that sills are widespread in the evaporite-dominated Upper Paleozoic series. (c) The location and extension of the Brazilian basins are set in relation to a reconstructed map of the CAMP at ca. 200Ma. (d) Modeled thermal effects of sills emplaced in Amazonas Basin sedimentary rocks at 1100°C in intervals of 10,000 years. Figure from Heimdal et al. (2018).

The TIMS U-Pb laboratory and the new stable isotope laboratory

The U-Pb zircon lab

A major upgrade of the U-Pb thermal ionisation mass spectrometer (TIMS) laboratory at the Department of Geosciences has been an important area of focus in 2016 and 2017. This effort has resulted in significant lowering of Pb blanks, recalibration of the U-Pb tracer to comply with the international EARTHTIME (earth-time.org) standards and a general update of laboratory protocols. The sum of laboratory advances implemented by Lars E. Augland (CEED) has allowed a two-fold improvement of analytical precision and single zircons can now be dated with a precision down to 0.1%. Ongoing projects spurred by these refinements include re-evaluation of the Upper Ordovician and Mid-Upper Devonian chronostratigraphies through high-precision U-Pb dating of ash beds in sedimentary successions (e.g. the ASHLANTIC project) and precise determination of volcanic activity associated with the Siberian Traps in Taimyr.

A New Stable Isotope Laboratory at UiO

Construction of a state-of-the-art stable isotope laboratory has been completed with joint support from CEED and the Institute for Biosciences (UiO). The laboratory is led and run by Anne Hope Jahren and William Hagopian, both at CEED. The lab will be committed to providing high-quality stable isotope analyses of $^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$ and D/H across a variety of geological and biological substrates. Housed within the laboratory is a complete stable isotope ratio mass spectrometer (IRMS) system that is capable of a wide array of sample-type analysis, ranging from rock and sediment, to stream and rain water, to plant and animal (including human) fossil and living tissues. Also included ia a Delta-V Advantage IRMS configured with an Elemental Analyzer Isolink System, and a Liquid Chromatography Isolink System (for compound specific $d^{13}C$ analyses).

Installation of the new laboratory (including space renovation, electrical supply and climate control) began January 1, 2017. The laboratory is expected to begin running samples collected from the Summer 2018 field season, starting during the Fall of 2018.

The ASHLANTIC project and the Paleocene-Eocene Thermal Maximum

The NFR-funded ASHLANTIC project is targeted at understanding the link between North Atlantic volcanism and the rapid climatic change during the Peleocene-Eocene Thermal Maximum. The project is led by researcher Morgan Jones, and PhD student Ella Stokke was hired in 2017 to work full time on the project. About 80 meters of core was retrieved during the August 2017 drilling campaign and was supplemented by outcrop samples. Approaches and methods include XRF core scanning, detailed isotope analyses and element geochemistry. The project includes numerous international collaborators and the first results will be published in 2018.

Figure 4.3. The ASHLANTIC project started core drilling the PETM on the island of Fur, Denmark, in August 2017. Numerous volcanic ash layers (black) are identified in outcrops and in the core. Photo: Henrik H. Svensen.

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5. Team Earth and Beyond: Comparative Planetology

The Earth and Beyond Team studies the similarities and differences between planetary bodies. Our research is following the main theme of CEED, which is to develop an Earth model that explains how mantle processes drive plate tectonics and trigger massive volcanism and associated environmental and climate changes throughout Earth history in 2017. We were able to reconcile three main scientific domains for Mars mineralogy, geochemistry and climate, and describe the transition from greenhouse to irreversible icehouse on Mars

One of the key objectives of this team is to study the geological history of terrestrial bodies. For Mars, we combined experimental and remote sensing work to decipher global climate change from mineral alteration. For Venus, using the volcanic record, which manifests the thermal evolution of planets on their surfaces, we investigated the influence of mantle convection on the shape of a planet and its gravitational potential field and gained insight into the current planetary interior structure and dynamics. Combined with the volcanic and superimposed crater record, planetary thermal evolution models can be constrained in time and space. Constraints in time are given by crater statistics, which is *the* tool for age determination on other planetary bodies. However, the crater formation process is influenced by many parameters, including those summarised as target properties. At small scale, the "strength" of the target limits the size of the crater. At large scale, it could be the temperature gradient for a given planetary object. Good understanding of the most recent, solar-system wide impact rates permits the transfer of the lunar cratering chronology to other planetary bodies than Moon.

Inferences on the mantle viscosity structure and the post-overturn state of Venus and continental motion of Earth

We performed global mantle convection models with the aim to understand the presently-observed gravity and topography spectra of Earth's neighbor Venus (Figure 5.1). These signals differ substantially from the corresponding observations on Earth, which indicates substantial differences in the internal structure of both planets, which are likely linked to different evolution scenarios (plate-tectonics on Earth vs. non-plate tectonics on Venus). In summary, our modelling results suggest that Venus' mantle has a viscosity profile that increases rather gently from sublith-

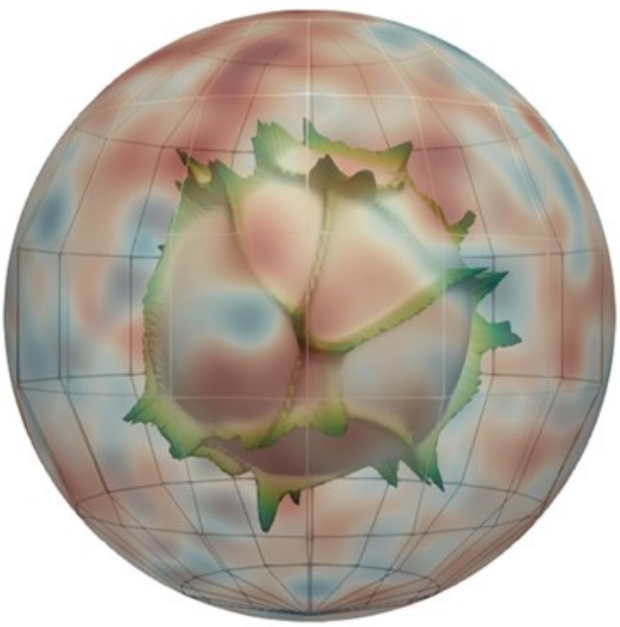

Figure 5.1. Example of a model simulating Venus' evolution from 4.4 Ga until present-day. Green-ish contours highlight anomalously hot regions in the deepest mantle indicating the bases of mantle upwellings. The transparent surface decodes the model-predicted topography (red – topographic high, blue – topographic low. Rolf et al., in review).

ospheric depth to the lower mantle (Rolf et al., in review).

Differently to Earth, a pronounced viscosity contrast across the upper mantle transition zone seems unlikely, because it typically violates the constraints from geoid and topography. This important difference may be related to different water contents in the upper mantle of Earth and Venus, possibly caused by the absence of re-hydrating subduction on the latter. Furthermore, our results indicate that an evolution scenario with at least one global overturn event produces other more Venus-like signatures, including thinner basaltic crust and more reasonable mean surface age, than a stagnant-lid scenario in which resurfacing is limited to purely volcanic processes. The research is ongoing and we will compare the surface record of volcanic units and impact crater statistics to evaluate the interior-surface relation further.

A similar approach has been used for global geodynamic models of the Earth's coupled mantle-lithosphere system, which self-consistently features plate tectonics and continental drift, to evaluate whether the evolution of continental configuration over deep geological time provides insight into the viscosity structure of the deeper interior (Rolf et al. 2017). These models also allowed evaluation, over which time span a set of continental cratons sample Earth's latitudes uniformly. This is a necessary, but challenged, condition to decide whether the database of paleomagnetic inclinations can be used to constrain the persistence of a geocentric axial dipole (GAD) magnetic field (Rolf, T; Pesonen L.J. in review).

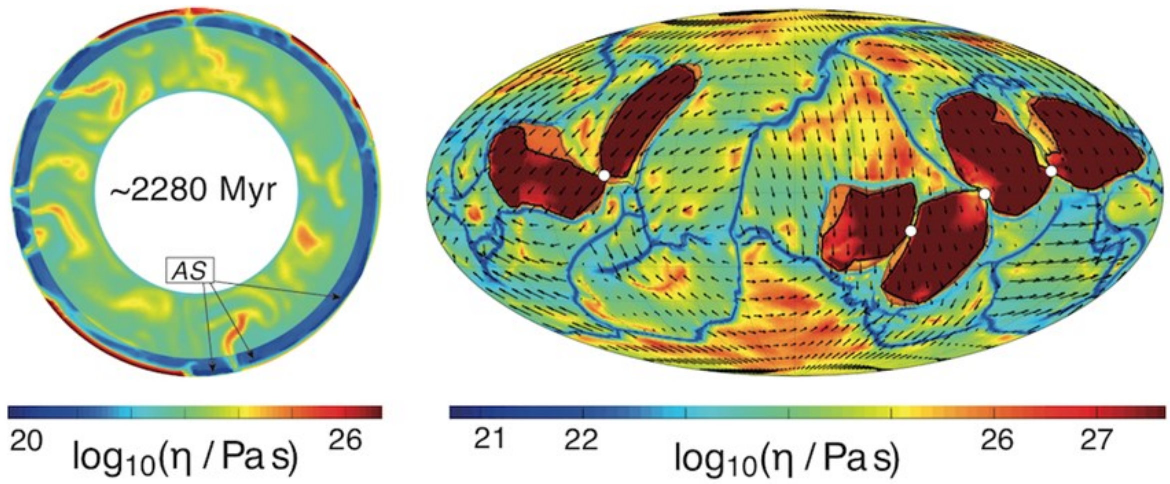

Figure 5.2. Snapshot from a model evolution: (left) Cross-section through the equator, (b) Mollweide projection of the surface. Both panels show viscosity as indicated in the color code. Black arrows in (b) denote surface velocity vectors. Continents are shown in deep red, weak plate boundaries in blue.

Mars climate change

We studied the global Martian climatic evolution, both with experimental work (Viennet et al., 2017) and based on remote sensing data (Bultel et al., in review). Our scientific activity focused on the experimental effect of CO2 levels in the experimental Martian atmosphere (pCO2) on the mineral formation from basaltic glass (Viennet et al., unpubl). This work allows promoting that the mineralogical assemblages are a good proxy to determine the geochemical conditions during Martian hydrothermalism with various CO2 content. Additional experiments were carried out in order to link the early Martian atmosphere, the mineral surface detection and the fluid compositions at Mars. For this we built a new experimental setting to mimic Martian weathering profiles. Due to new detections on the Martian surface in agreement with the experimental results (Figure 5.3.), this work reconciles three main scientific domains for Mars mineralogy, geochemistry and climate.

Weathering profiles on ancient Martian terrain suggest that surface water caused alteration of the rocks and required a different, warmer climate than on Mars today. Predictions of the nature of such early Martian climate with CO2 vapor as the main component causing greenhouse warming has been challenged by the lack of carbonate finds in these profiles. We developed a new tool to analyze spectral-imaging data, and were able to detect carbonates mixed with hydrated minerals in these weathering profiles. These carbonates are the missing link to an early Martian climatic environment with a CO2 atmosphere dense enough to permit liquid water at the Martian surface for the first 850 million years. Trapping CO2 in these weathering profiles reduced the atmospheric pressure, including greenhouse effects, and turned Mars into its present icehouse condition (Figure 5.4). A good understanding of the climatic evolution sets Martian habitability into context (Vago et al., 2017).

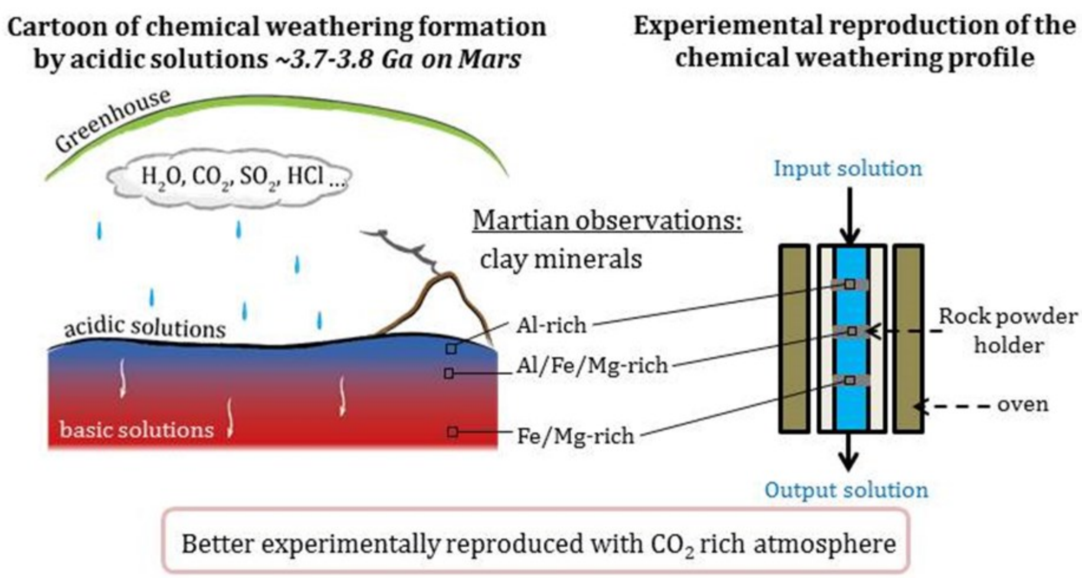

Figure 5.3. Chemical weathering by acid solution as suggested for Mars and reproduced in the laboratory.

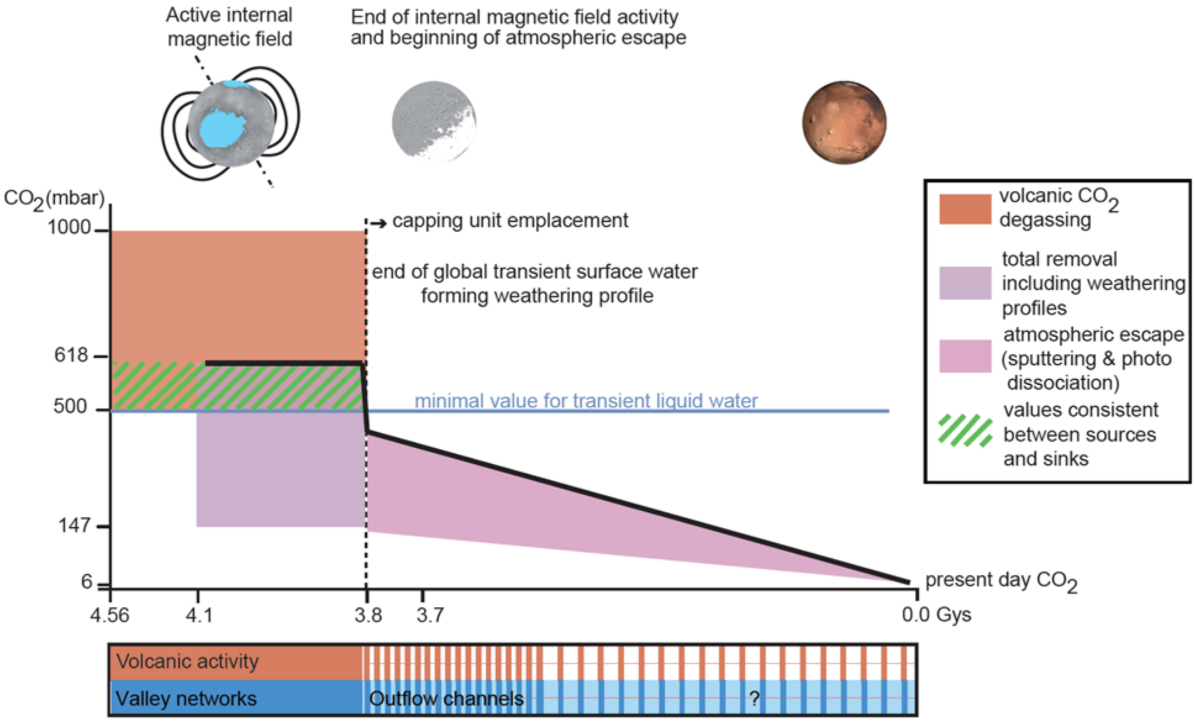

Figure 5.4. Schematic evolution of the CO_2 pressure stored (light purple), escaped (purple), and released by volcanic activity (orange). The different colored areas describe the contribution of the different processes; the straight lines do not reflect the real process rates. The dotted black line indicates the approximate formation age of the capping unit. The blue line indicates the lower level of CO_2 needed to sustain (transient liquid) water. The green hatched area indicates the values consistent between removal processes and volcanic outgassing. The volcanic activity is decreasing after 3.8 Gyrs and the magnetic field ceased at around 3.8-3.7 Gyrs. The evolution of a wet Mars toward a cold Mars and then dry Mars are sketched by planet illustrations. Before 3.8 Gyrs ago, the valley networks formed. Subsequent water activity is limited to mainly outflow channels.

Cratering rates and crater formation

This broad theme aims to understand the long term evolution of small solar system bodies like comets, asteroids, Kuiper Belt Objects (KBOs), Trans Neptunian Objects (TNOs) and meteoroid swarms. A key aim was to find how long term relativistic effects like general relativistic precession and long term secular effects like Kozai oscillations (Figure 5.5.) affect each other and in-turn affect the Minimum Orbit Intersection Distance (MOID) between small bodies and Earth. MOID plays a crucial role in assessing close encounter and collision scenarios between bodies in space. Estimation of MOID and long-term impact probabilities can be done by analytical (using Öpik formulae), semi-analytical (using modified Öpik-Greenberg-Wetherill algorithms) and numerical methods (numerical integrations), and one can correlate theoretical results and observed data.

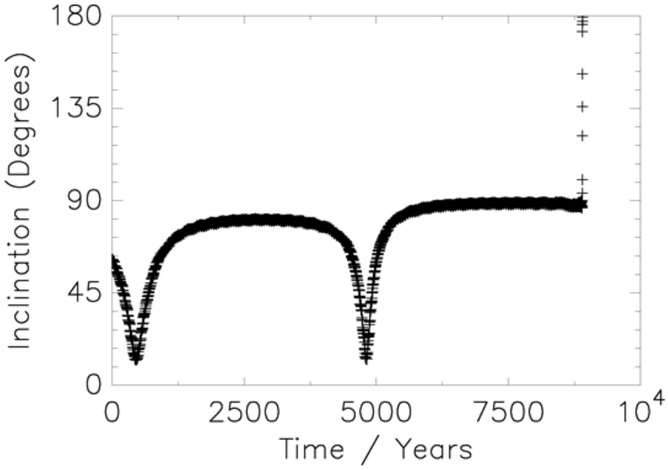

Figure 5.5. Orbital evolution of inclination of comet 96P/Machholz 1 for 9 kyr in future (before it collides with the sun due to eccentricity reaching unity). Notable peaks and dips in inclinations caused by long term Kozai oscillations change MOID and impact probabilities at multiple times (Plot taken from Sekhar et al. 2017).

The record of impact craters can tell about the structure and evolution of the surface of a planetary body. The morphology and number of craters are the best available constraints on the chronology of planets. Remote sensing techniques give the possibility to investigate planetary surfaces and their impact structures at high resolution. However, our knowledge about the detailed crater formation process remains fragmentary and surprisingly little is known about how the observed cratering record is linked to the properties and structure of the targets body.

This lack of insight motivates us to address how an impact crater evolves in response to the material properties of the target body. Focus is on the Moon as the Solar System's planetary object with the most comprehensive cratering record and on craters smaller than about 16 km, as they are the most affected by changes in material properties. We explored three main questions; (1) The formation of the transient crater, i.e. the early stages of crater evolution; (Prieur et al., 2017); (2) The modification from the transient to the final, observed crater, and (3) how the presence of multiple layers with different properties in the target impacts crater evolution and relates to the variety of observed crater morphologies on the Moon

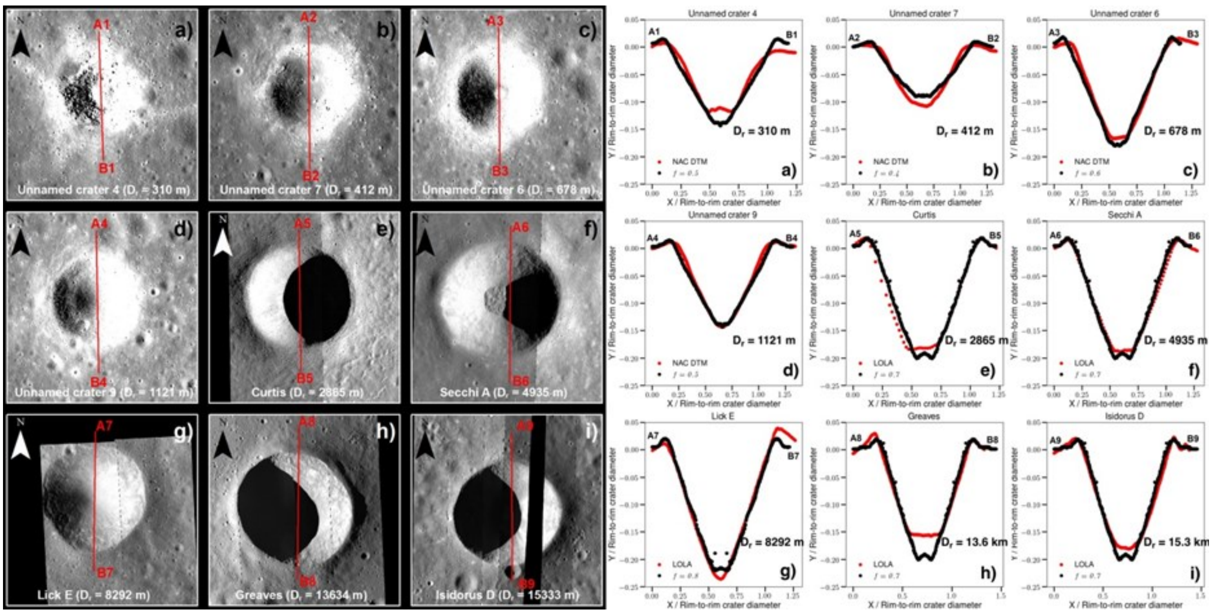

Figure 5.6. Cratering on Moon: Nature and models fit well, and provide confidence on the selected parameter range.

(Prieur et al. In review). Each of these main questions is investigated with the help of numerical impact modelling.

One of the main findings is that the target's coefficient of friction is of first-order importance for the resulting geometry of the impact crater. Moreover, two-layered targets reveals a much more complex evolution of crater formation than previously thought and leads to a much wider variety of final crater morphology that mostly depends on the impact velocity and strength contrast of the different layers. These findings provide an interesting future perspective since observed crater morphologies on the Moon, but possibly also other planetary bodies, may thus be used in combination with numerical results and scaling laws to infer subsurface target structure. (Figure 5.6)

The numerical experiments were performed on NOTUR facilities in the frame work of the NFR Crater Clock project. Mars research was supported by the EU H2020-COMPET-2015 scheme funded project PTAL (Planetary Terrestrial Analogues Library).

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The Earth Laboratory Team aims to construct paleogeographic reconstructions for the last 600 million years based on paleomagnetic data and other geological and geophysical observations. In 2017, our team members led three studies in high-impact journals (Nature Communications and Science Advances). Two of these present a kine-matic analysis of a prominent change in the Pacific plate motion 50 million years ago, and developed a new tectonic model explaining that change. The third concerns veracity of estimates of the paleointensity of geomagnetic field derived from laboratory Thellier experiments.

Paleogmagnetism

In 2017, the researchers of the Earth Laboratory team organized two fieldwork trips for paleomagnetic sampling. As a continuation of the study of paleographic position of Baltica in Neoproterozoic time, samples of Precambrian mafic intrusions in the Telemark sector of southeastern Norway were collected for paleomagnetic and geochronologic analysis. Demagnetization experiment has recently been completed and paleomagnetic data are currently analyzed. New Ar-Ar radiometric dates obtained from this collection constrain the age of magnetization of the rocks from Bamble and Telemark sectors of SE Norway to 1100 – 1050 Ma and 1020 Ma, respectively. A large number of Mesozoic and Precacmbrian diabase dykes in southwestern Greenland have been sampled for paleomagnetism and geochronology. The main objective of this project is to provide tighter constraints on the paleogeographic fit between North America, Greenlad and Europe in the middle-late Jurassic (ca. 150-170 Ma), and to test the hypothesis of fast polar shift (true polar wander) as suggested by the analysis of North American data. Preliminary measurements of paleomagnetic samples from Greenland reveales positive baked contact tests for both Mesozoic and Precambrian dykes, indicating excellent magnetic stability and primary nature of remanent magnetization in these rocks (Figure 6.1). Other paleomagnetic projects focusd on

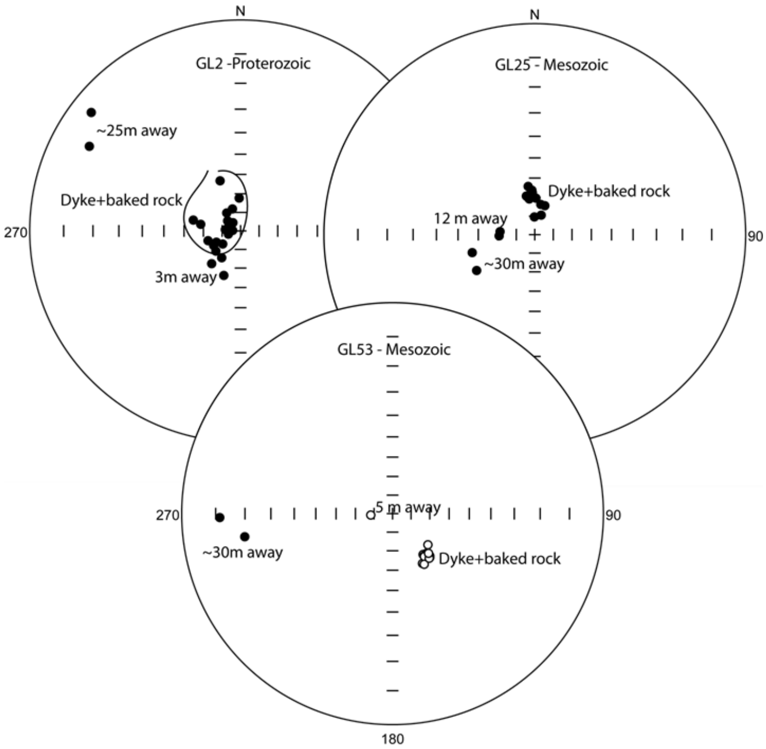


Figure 6.1 Positive baked contact test for diabase dikes of southwestern Greenland attesting to the primary nature of recovered magnetization.

rocks from (1) the ~510 Ma Kalkarindji large igneous province from northwest Australia, (2) the Triassic Nicola Group and Cretaceous Spences Bridge Group from western Cananda, and (3) Permian volcanics of Morocco. Work on these projects will continue through the next year.

The intensity of geomagnetic field in the geologic past and how it relates to the processes of field generation in the Earth's liquid core (geodynamo), morphology of the field and frequency of geomagnetic reversals, is another direction of research we have pursuied in 2017. Kulakov and collaborators (Smirnov et al., 2017), presented laboratory experiments that identified a fundamental mechanism that results in a pervasive and previously unrecognized low-field bias that affects most paleointensity data in the global database (Figure 6.2). These findings can explan why the paleointensity data obtained from volcanic rocks using the Thellier method as yet failed to confirm the inverse relationship between the field strength and reversal frequency predicted by numerical models of geodynamo.

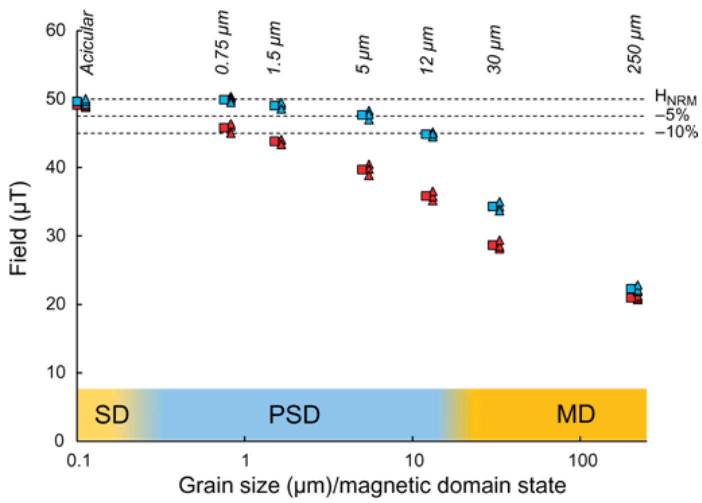


Figure 6.2. Negative field bias of paleointensity estimates obtained using the traditional Thellier (red

Paleogeographic reconstructions for Paleozoic and Precambrian time

Paleographic reconstructions provide a key for linking the surface motion of tectonic plates with the convective motions in the Earth mantle, and producing such reconstruction is one of the main goals of the Earth Laboratory team. A new regional full-plate model for the early Paleozoic tectonics of Asia has been developed (Domeier, 2018; Figure 6.3). The project involved the construction of a continuously-closing plate polygon model for the region between 500 and 420 Ma. The model includes a comprehensive integration of paleogeographic and tectonic data with paleomagnetic, paleobiologic, structural, stratigraphic, petrologic, geochemical and geochronological data. The work is a module of an on-going, overarching project to construct a spatially and temporally seamless plate tectonic model of the Earth for the last 600 Myr. A new methodology paper (Domeier and Torsvik, 2018) detailed how these next-generation plate models are made.

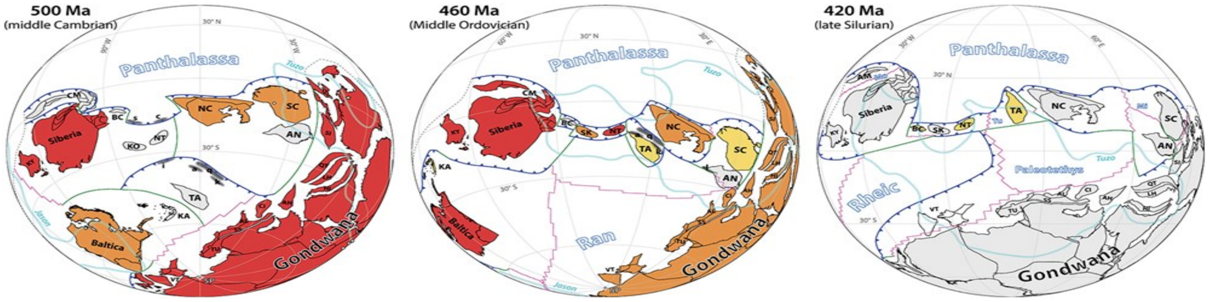


Figure 6.3. Graphical summary of Early Paleozoic plate model for Asia (Domeier, 2018).

Ongoing work on compilation and kinematic modelling (restoring continents, building polylines and testing kinematics; Domeier and Robert, work in progress) is in regions that have not yet been covered by continuously closing plate polygons for the 500-420 Ma time interval, and preliminary compilation and modelling work in the Precambrian-early Cambrian interval A related study of paleogeography of continents between 615 and 565 Ma (Figure 6.4) was conducted by Robert and colleagues (Robert et al., submitted). Here the hypothesis of true polar wander during the Ediacaran period (635-541 Ma) was tested using mantle dynamics models. A new tectonic model that explains differences between the coeval Sveconorwegian and Grenville orogenies in Proterozic between ca. 1140 nad 920 Ma, has been published by Kulakov and co-workers from the Geological Survey of Norway (Slagstad et al., 2017).

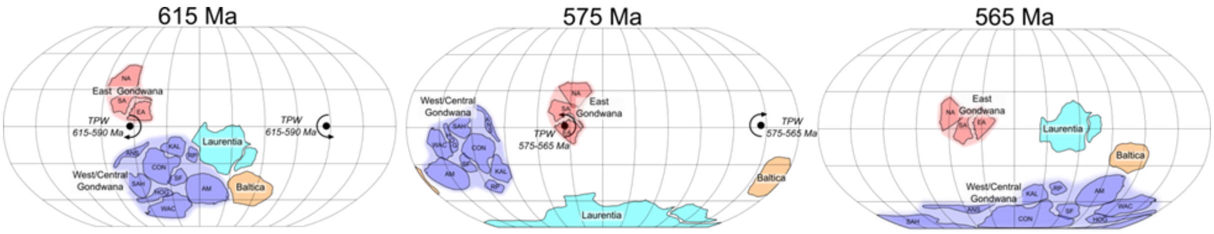
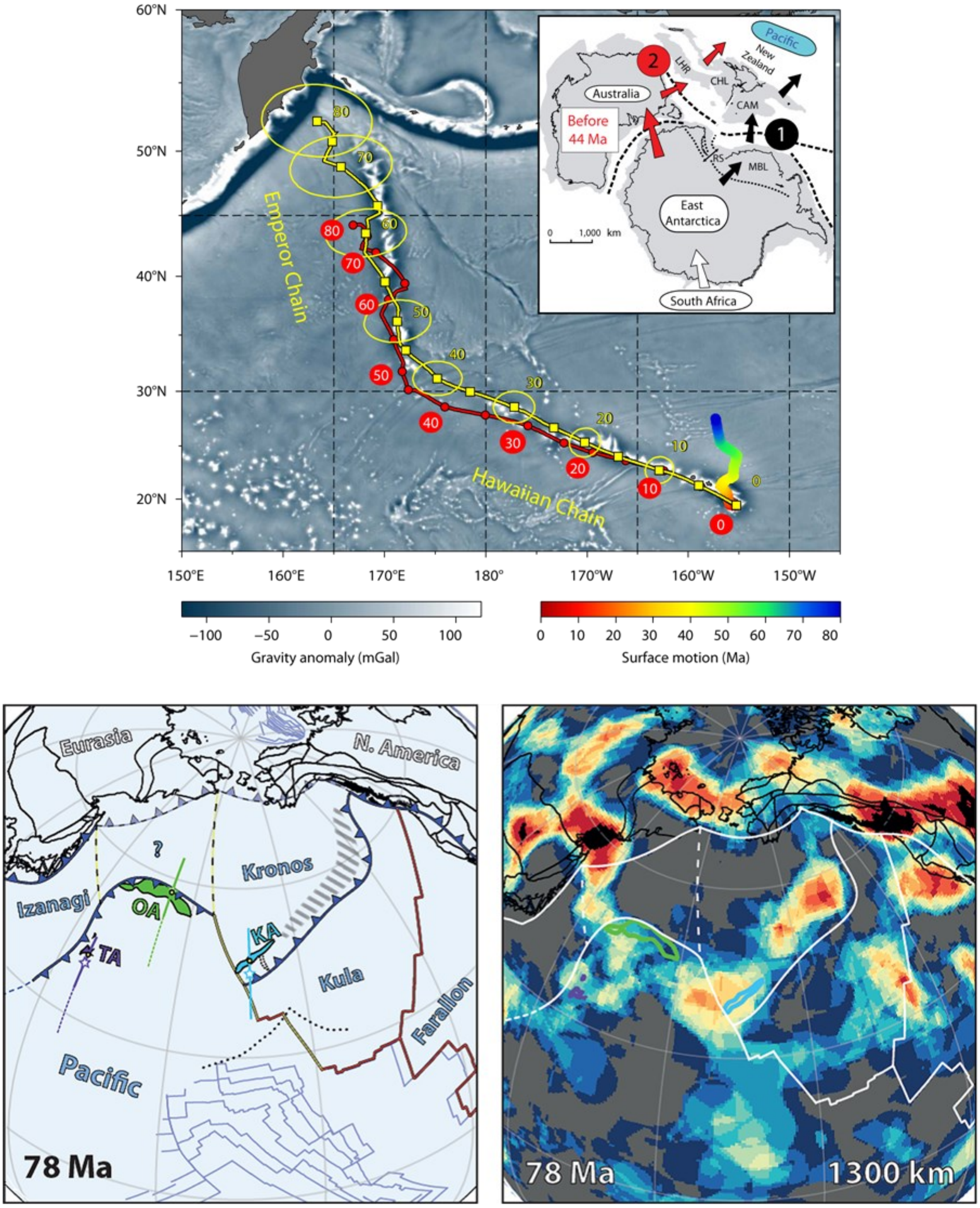


Figure 6.4. Paleogeographic reconstruction for the main Ediacaran continents at 615, 575 and 565 Ma (Robert et al., submitted).

Figure 6.5. (opposite page) Top: Model tracks of the Hawaiian-Emperor chain based on absolute motions of the Pacific plate with (yellow line) and without (red line) contribution of the southward drift of the Hawaiian plume (rainbow-colored swath) (Torsvik et al., 2017). Bottom: Configuration of the intraoceanic subduction system in the northern Pacific basin in the Late Cretaceous inferred from seismic tomography and paleomagnetic data (Domeier et al., 2017).

Pacific plate motion in the Late Cretaceous and Paleogene

A prominent bend in the Hawaii-Emperor chain has long been considered as evidence for a major tectonic reorganization that caused an abrupt change in the direction of the Pacific plate motion at about 50 million years ago (Figure 6.5). The reasons for that reorganization have, however, remained enigmatic for years. Torsvik et al. (2017) showed that the bend was not caused by fast southward drift of the Hawaiian plume in late Cretaceous through middle Eocene time (84-47 Ma). Torsvik et al (2017) showed through kinematic and geodynamic modeling of absolute motions of the Pacific plate and the Hawaiian plume, that the southward drift of the plume cannot be a sole or dominant mechanism for the formation of the bend. These findings imply that the geometry of the Hawaiian-Emperor chain, which partly



reflect the southward motion of the plume, cannot be explained without invoking a prominent change in the direction of Pacific plate motion around 50 Ma. A follow-up study of Domeier et al. (2017) investigated the underlying tectonic mechanism for this change. This analysis brought together geologic data, paleomagnetic data and seismic tomography to show that a major intraoceanic subduction system which has not been recognized in conventional plate models, was active in the Late Cretaceous-Paleocene in the northern Pacific Ocean (Figure 6.5). The analysis of evolution of this subduction system suggests that its demise and collision between the intraoceanic arc and the northeastern margin of Asia in early Eocene time altered the plate boundary force balance, resulting in a major tectonic reorganization that has been responsible for the change in the motion of the Pacific plate recorded by the geometry of the Hawaiian-Emperor bend.

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Paleomagnetic sampling from diabase dykes of southwestern Greenland (August, 2017).

Ivar Giæver Geomagnetic Lab activities

In 2017 we launched a visiting fellowship program that provides access to the laboratory instruments for external users from Norwegian and international research institutions. Ten projects were selected based on an evaluation of quality of the scientific proposals, and the topics includes studies in paleomagnetism, rock magnetism, environmental magnetism, archeomagnetism and magnetostratigraphy. Nine of the projects have been completed. One visit from a partner institution (University of Bergen) was organized outside the visiting program. The projects are listed Table 6.1.

Table 6.1.	The Visiting programme
Alexander Mitchell, PhD student, NTNU	Paleomagnetism of the Leka Ophiolite Complex, central Norwegian Caledonites
Kseniia Bondar, Taras Shevchenko National University of Kyiv, Ukraine	Magnetic mineralogy of polluted soils and industrial dusts from the city of Zaporizhzhya (Ukraine) – the powerful metallurgical center
Benjamine Lysak, University of Alberta, Canada	Obtaining reliable paleomagnetic poles for Cambrian of South China block
Dmytro Hlavatskyi, Subbotin Institute of Geophysics of the National Academy of Sciences of Ukraine, Kiev, Ukraine	Magnetic properties and magnetostratigraphy of Pleistocene loess-palaesol sections from Ukraine
Evdokia Tema, University of Torino, Italy	Archaeomagnetic investigation of ancient ceramics from Italy: A contribution to the reconstruction of the past geomagnetic field secular variation
Aleksey Smirnov, Michigan Technologocal University, USA	Investigation of partial thermal remanent magnetization behavior at cryogenic temperatures: Towards robust paleointensity determinations
Luis Alejandro Rodrigues Parra, UNAM, Mexico	Tracking the Tectonic Evolution of the Mexican Jurassic Arc: A aleogeographic insight from Paleomagnetism
Joonas Wasiljeff, University of Helsinki, Finland	From a greenhouse to an icehouse world – environmental change across the Eocene – Oligocene transition in Ulantatal, Inner Mongolia
Anthony Pivarunas, University of Florida, USA	Preliminary magnetostratigraphy across the Frasnian-Fammenian boundary, New York

Outside the visiting programme:

Erik Halvorsen (University of Bergen, visiting) DrPhilos project *Paleomagnetism and magnetic anisotropy of sills from the Early Cretaceous Diabassoden suite, Svalbard.*

DEEP and teaching at CEED

CEED scientists participate in several teaching activities. In addition to teaching regular courses at the Department of Geosciences (see Table on the opposite page), they were involved in coordinating, running and lecturing in several DEEP courses as following:

GEO-DEEP9500 Earth Magnetism and Paleogeography from the Precambrian to the present (3 – 7 April 2017)
The main objective of the course is to give students a comprehensive overview of the Earth magnetism at the present time (geomagnetism) and in the geologic past (paleomagnetism), including its applications for reconstructing the paleogeography through geologic time, which lays down the essential foundation for our understanding of the evolution and dynamics of the Earth at planetary scale. The course was organised by Pavel V. Doubrovine (CEED) ; out of 3 participants, 1 student was from CEED (Kjøll).

GEO-DEEP9200 Earth and planetary materials and dynamics (8 – 13 May 2017)
The course treats Earth and planetary differentiation to form core, mantle and crust and gives insights into the seismic structure, heat production, heat flow and convective dynamics of the Earth. The course was organized and taught by Reidar Trønnes (CEED) and had 14 participants, 4 of them from CEED (Uppalapati, Heyn, Straume and Løken)

GEO-DEEP 9300 Lithosphere and Asthenosphere: Composition and Evolution (6 – 10 November 2017)
This course deals with the composition and evolution of the crust, lithospheric mantle and asthenosphere. Seismic imaging techniques and interpretation of tomographic images in terms of composition and physical properties will be coupled with recent results in petrology, geochemistry and geodynamical modelling to review recent advances in our understanding of the evolution and present state of the continental as well as oceanic lithosphere. Course responsible and teachers were Valerie Maupin and Clint Conrad, both from CEED. A total number of 6 students took the course, two of them from CEED (Heyn and Karlsen).

GEO-DEEP9500 Large igneous provinces and their environmental impacts (11 – 15 September 2017)
This intensive PhD course covered many of the key subjects related to the formation and evolution of Large igneous provinces. The participants learned about LIPs and mantle processes, plate reconstructions, how to date basaltic rocks, volcanology of LIPs, sill emplacement and geochemistry, contact metamorphism and degassing, global carbon and sulfur cycles, atmospheric effects of degassing, the usage of carbon isotopes and environmental proxies, the relationships between LIPs and environmental changes based on case studies from events like the end-Permian, the end-Triassic, the Toarcian, and the PETM. The course included exercises in thermal modelling, rock displays, lab visits, and a field trip in Oslo region. The course responsible was Henrik Svensen (CEED), and 11 CEED scientists, including 3 Early Career Researchers, participated in teaching (Augland, Callegaro, Conrad, Gaina, Hagopian, Jahren, Jerram, Jones, Kürschner, Planke, and Torsvik). There were 28 participants, with 7 students from CEED (Tan, Straume, Zaputlyaeva, Stokke, Heimdal, Bostic and Uppalapati).

Teaching by CEED staff at UiO

DEEP courses are given in **bold**

Course code & name	Semester	ECTS	Course responsible / assisting
GEL2140 Geofysikk og global tekto-nikk	Spring	10	**A.J. Breivik**
GEL2150 Field course and methodolo-gy in geology and geophysics	Spring	10	Lundmark/**L.E. Aug-land**, **H.J. Kjøll**
GEO4120 Near-Surface Geophysics	Autumn	10	**A.J. Breivik,** Sara Bazin
GEO4240 Seismic interpretation	Spring	10	**J.I. Faleide,** M. He-eremans
GEO4270/9270 Integrated basin analy-sis and prospect evaluation	Autumn	10	**J.I. Faleide,** M. Heeremans
GEL4360 Field methods in hydrogeo-logy	Spring	5	A. Sundal, P. Aagaard, C. Sena, **A.J. Breivik,** H. French (NMBU).
GEO4630/9630 Geodynamics	Autumn	10	**S. Werner / B. Stein-berger, S. Buiter**
GEO4840/9840 Tectonics	Spring	10	**T.B. Andersen / C. Gaina, M. Domeier**
GEO4860/GEO9860 Advanced Petro-logy		10	**R.G. Trønnes** / B. Jam-tveit
GEO4620/9620 Seismic waves and seismology	Autumn	10	**V. Maupin**
GEO-DEEP 9200 Earth and planeta-ry materials and dynamics	Spring	5	**R. Trønnes**
GEO-DEEP 9300 Lithosphere and Asthenosphere: Composition and Evolution	Aurumn	5	**V. Maupin, C. Conrad**
GEO-DEEP9500 Earth Magnetism and Paleogeography from the Precambrian to the present	Spring	5	**P.V. Doubrovine,** Lauri J. Pesonen (Univ. Hel-sinki)
GEO-DEEP9500 Large igneous pro-vinces and their environm. impacts	Autumn		**H. Svensen and the Earth Crises Team**
SSMN4030 - A changing Arctic	Summer School	15	**C. Gaina, G. Shephard**

Picture on the left side: Henrik Svensen and students at a field excursion at Sognsvann in Oslo, as a part of the CEED-DEEP 9500 course Large Igneous Provinces and their Environmental Impacts.

PhD student projects

Name	Topic	CEED supervisors	Funding
Baron Marzena A.	**Melting relations at pressure of the Earth`s lower mantle. Completed in 2017**	Trønnes, Mohn, Gaina	**UiO**
Broek, Joost van den	The role of subduction in the formation and evolution of continental slivers and microcontinents	Gaina, Buiter, Gabrielsen, TB Andersen, Magni	EU
Bostic, Joshua N.	Reconstructing the magnitude and societal effects of acute climate changes during the Viking dark ages	Jahren	UiO
Heimdal, Thea H.	The geochemistry of sill-sediment interactions and the implications for global environmental crises – case studies from the Tunguska, Amazon and Solimões Basins	Svensen, Callegaro, Jones, Trønnes	UiO & SFF
Heyn, Bjorn H.	Convective dynamics in the lowermost mantle	Conrad, Trønnes, Aller	UiO
Husein, Alwi	Geophysical investigations at the Lusi eruption site	Mazzini,	EU
Karlsen, Krister S.-	The effects of water on mantle convection dynamics - Linking the Earth's hydrological, thermal and tectonic histories	Conrad, Trønnes, Magni	UiO
Karyono	**Seismic monitoring of LUSI: A unique natural laboratory for multidiciplinary studies focussed fluid flow in sedimentary basins. Completed in 2017**	Mazzini.	**EU**
Kjøll, Hans Jørgen	Wilson-cycle 'kick-off': Large Igneous Provinces, the Neoproterozoic and Cambrian evolution of Baltica and adjacent continents - Case studies from the Scandinavian Caledonides and High Arctic LIP	TB Andersen, Torsvik	RCN & SFF

PhD student projects (cont.)

Name	Topic	Internal superv.	Funding
Prieur, Nils C.	The influence of target properties on simple crater evolution. Submitted in 2017.	Werner,	RCN
Stokke, Ella W.	The effects of volcanic eruptions and degassing during the North Atlantic LIP on the PETM thorugh geochemical analyses and studies of ash layers i the Fur Fm, Denmark	Jones, Svensen	RCN
Straume, Eivind O.	Paleoclimate in the Cenozoic time: Quantifying the role of North Atlantic plate tectonicsa amd mantle processes	Gaina, LaCasce, Nisancioglu, Svensen	UiO
Tan, Pingchuan	Magmatic development of the Jan Mayen -East Greenland corridor, NE Atlantic	Breivik	UiO
Zastrozhnov, Dmitry	Structure and Evolution of Mid-Norway Continental Margin	Faleide, Planke, Gabrielsen	RCN
Zaputlyaeva, Alexandra	Fluid-rock interactions and geochemistry of the Lusi mud eruption, Java, Indonesia	Mazzini, Svensen	UiO

The celebration of Marzena Baron`s PhD defence at CEED 16 June 2017.

FORM - From Orogens to Rifted Margins and Back: The formation and deformation of continental margins through Wilson Cycles (6-9 June 2017, St. Florent, Corsica)

Organisers and programme committee: C. Gaina (CEED), P-T. Osmundsen (NGU), V. Magni and J. Jakob (Early Career Scientists, CEED), F. Gueydan (University Montpellier, France) and T-L. Gørbitz (CEED).

CEED organised an international meeting for presenting and discussing the state-of the-art of our knowledge on the evolution of continental margins through the Wilson Cycle. Remarkable advancement in discovering the complex structure of passive margins led to a paradigm shift in our concepts about how continents break up. Moreover, highly extended passive margins seem to be prone to subsequent deformation and even the locus of subduction initiation. Old continental margins that experienced at least one tectonic Wilson cycle preserve valuable information about continental break-up, incipient oceanic crust formation, and subsequent obduction and collision. Two large European continental margins - one preserved in the Caledonides (Scandinavia) and the other one in the Alps and Mediterranean realm, are rich laboratories for studying the Wilson Cycle stages. Notably, evidences for continental passive margin complexities originated from the Alpine realm, when combined with results from Ocean Drilling Programme, gave a complete picture of a different class of margins, which are now called "hyperextended margins" (e.g. *Manatschal, 2004*). In the last couple of years, geological evidences describing an older hyperextended margin that belonged to Baltica, were collected from the Caledonides – a region which preserve information about a complete Wilson Cycle (e.g. Andersen et al. 2012). This region is now in the middle of its second Wilson cycle, being adjacent to a more recently formed passive margin and oceanic basin.

The FORM meeting aimed to review current knowledge about continental margins that underwent several tectonic cycles, and attempted to understand the transition from one tectonic regime to another, and review the concept of WILSON CYCLE. The conference venue was in northern Corsica (France), in order to take advantage of the availability of several localities with exposed rocks and tectonic structures linked to several Wilson cycle stages. The rocks comprise continental, oceanic, and mantle rocks of a fossil Tethyan hyperextended magma-poor margin, which was subsequently metamorphosed during the Alpine subduction and thrust over the Hercynian autochthonous basement to the southwest, as well as post-orogenic basins within a small and easily accessible area.

Form was organised into a two-days days meeting with oral and poster presentations and 1 day of field trip visiting several localities in northern Corsica. 29 participants, including 7 Early Career Scientists from Norway, France, Denmark, USA and Italy, presented their results within 5 sessions:

1. The "Wilson Cycle": pre-Atlantic stories
2. Passing the torch though the Wilson Cycle-the role of inheritance
3. Rifting and Passive margin formation
4. Subduction, Collision and Orogeny
5. Mantle Dynamics and the Wilson Cycle

The meeting programme, contributed abstracts and the field trip guide can be accessed here:
http://www.mn.uio.no/ceed/english/research/news-and-events/events/conferences-and-seminars/the-form-conference.html

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Manatschal, G. 2004. New models for evolution of magma-poor rifted margins based on a review of data and concepts from West Iberia and the Alps. Int J Earth Sci (Geol Rundsch) (2004); 432-466.

CEED – Conceiving Earth Evolution and Dynamics
(17 – 20 October, ULL, San Cristóbal de La Laguna, Tenerife North)

Organisers and programme committee: C. Gaina, P. Doubrovine, C. Conrad, J.I. Faleide and T.-L. Gørbitz

The **Plate Tectonics** theory took shape in the 60's after paleomagnetism proved continental drift, as Wegener suggested half a century before; and magnetic anomalies of oceanic crust attested mantle convection as a mechanism for breaking and assembling continents and recycling oceanic crust. The historical paper of Jason Morgan in 1971 ("*Convection plumes in the lower mantle." Nature.* ***230***) established, for the first time, a link between deep mantle processes and surface volcanism. The first tomographic models of Dziewonski and collaborators (Dziewonski et al., 1977; Dziewonski, 1984) imaged degree two large topographical features on the core-mantle boundary, later named the LLSVP (Large Low Shear-wave Velocity Provinces) regions, which play an important role in the evolution of our planet.

The links between the Earth's surface and deep mantle have been explored incessantly since, a decade ago, Burke and Torsvik published a series of papers showing that large-scale volcanism is triggered by deep-seated mantle plumes located at the edges of LLSVPs at the core -mantle boundary.

CEED organized a special conference on the volcanic island Tenerife (an island presumably formed by hotspot volcanism), where geologists, geophisicists and modellers assembled for presenting and discussing our present understanding of how the evolution of plate tectonics and mantle dynamics can be linked by using better knowledge of paleomagnetic data from land and oceans, state-of-the-art tomographic models of Earth's mantle, geodynamic modeling, and observations of volcanic eruptions, including the Large Igneous Provinces.

The three-days conference was organized in two main sessions: (1) Earth History, Paleomagnetism and Paleogeography, and (2) Deep Earth and Mantle Dynamics where 48 scientists from 10 countries presented their results. Part of the conference was a one-day field trip to visit the most important volcanic structures of the island.

The Early Career scientists participating in the conference had an additional half-day forum where they discussed future collaboration and possibilities of common scientific proposals.

The meeting programme, contributed abstracts and the field trip guide can be accessed here:

http://www.mn.uio.no/ceed/english/research/news-and-events/events/conferences-and-seminars/the-ceed-conference.html

Conference participants and CEED SAB members during the field excursion at Teide volcano, Tenerife. The excursion was part of the CEED conference. In the central background: Mirador del Dedo de Dios, God`s Finger.

Henrik H. Svensen received the Outreach Prize from the Norwegain Research Council (RCN) for his research dissemination through numerous channels for many years. The prize was handed over by Thomas Evensen in the NRC (photo: Yngve Vogt/Apollon).

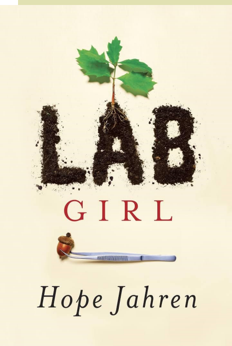
Svensen regularly writes in the Norwegian newspaper Morgenbladet, and appears in radio and TV.

Trond H. Torsvik participated in the open-source TV series "The Mind of the Universe".

The TV series is produced by VPRO, a Dutch Public broadcaster. Trond appeared on May 28 as the only Norwegian scientist in this series.

CEED`s Wilson Professor **Anne Hope Jahren** talked about Science and Norway, and plant life in an interview in Aftenposten in September, and also at the Saturday evening TV show "Lindmo" at NRK1.

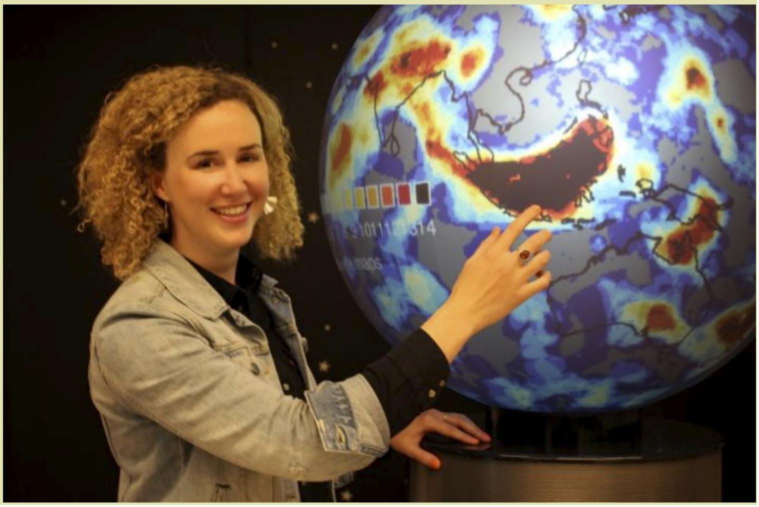
Jahren won The National Book Critics Circle Award for her book *Lab Girl***.**



Trond H. Torsvik, Pavel Doubrovin, Bernhard Steinberger, Carmen Gaina, Wim Spakman and **Mathew Domeier** received considerable media attention for the article published in *Nature Communication* (8, 2017): Pacific plate motion change caused the Hawaiian-Emperor Bend. The work was widely cited internationally, for instance in Science Daily, EurekAlert!, Science Newsline, Science Daily and Space Daily, as well as nationally in Forskning.no and Titan.no

Hawaii sits at the end of a seamount chain of volcanoes running across the Pacific Ocean floor, but in the middle of this chain lies a bend of 60 degrees. This is the Hawaiian–Emperor seamount chain. For many decades geoscientists have struggled to explain exactly how and why this feature occurred around 50 Million years ago. Mathew Domeier and colleges shed light on this long-standing geological controversy – A massive collision at the edge of the Pacific Ocean was the culprit, as documented in his study in *Science Advances* The work was documented in a CEED YouTube movie, which was launched through the CEED Facebook page.

Grace Shephard and covorkers published an article in *Scientific Reports* (7, 2018) about the disappearance of ancient oceans and how they can be mapped deep in the Earth. A simple yet effective methodology was applied to survey alternative models of the Earth's interior structure (seismic tomography) and identify the most robust features. The article focused on subducted slabs of oceans and found interesting changes in the amount of slabs with depth, possibly explaining a time in the past when there was more ocean destruction or a depth range which causing a slab traffic jam. The work was an early career initiative with colleagues from CEED and the University of Oxford, and has already been used for different geodynamic applications, including for the cause of the Hawaiian-Emperor Bend (Domeier et al., 2017). It was picked up in several media outlets including the EGU GeoLog Blog and Titan.no. Photo: Dag Inge Danielsen.



CEED`s stand at Forskningstorget (The Research Fair), Oslo downtown in September. 2017 Small picture to the right: making planets. Photo: Vanja Haugland

International cooperation

Country	Activity	Person(s) involved
Australia	Joint publications, collaboration, visits	C. Gaina, E. Straume, G. Shephard, H.J. Kjøll
Brasil	Collaboration, joint publication	H. Svensen
Denmark	Field work (Fur, Greenland), joint supervision and collaboration, joint publications	M. Jones, T.B. Andersen, H.J. Kjøll, P. Doubrovine, E. Kulakov, C. Gaina
France	Visiting students, Field work	T.B. Andersen, J. Jakob, C. Gaina, A. Minakov, S. Werner
Germany	Visitors; Joint publication (s)	T.B. Andersen, B. Steinberger, S. Werener, V. Fernandes, A. Mazzini, C. Gaina
Iceland	Collaboration	C. Gaina
Indonesia	Joint research project	A. Mazzini
Japan	Collaboration	R. Trønnes, S. Werner
Russia	Field work; Research cooperation; Joint publication(s)	A. Polozov, R. Kulakov, C. Gaina, J.I. Faleide, A. Minakov, A. Mazzini
South Africa	Field related work; Joint publication(s)	T.H. Torsvik, H. Svensen,
The Netherlands	Joint publication(s), research collaboration, Exo Mars landing site.	T.H. Torsvik, W. Spakman, C. Gaina, S. Werner
Turkey	Collaboration	M. Domeier, T.H. Torsvik
UK	Lab work; Joint publication(s)	J. Dougal, R. Trønnes, M. Baron, T.H. Torsvik & R. Cocks, G. Shephard, V. Maupin, F. Crameri
USA	Joint publication(s), Lab. Facilities, studetn visit, research cooperation	H. Stein, J. Hannah, C. Conrad, A.H. Jahren, T.H. Heimdal, C. Gaina
Canada	Research cooperation	C. Gaina

Master student projects

Name	Topic	CEED supervisor(s)
Ballo, Eirik	**A new age model for the Ordovician K-bentonites in Oslo, N. Completed in June 17.**	**Svensen, Augland**
Bruland, Charlotte	Ambient noise tomography at the Oseberg oil and gas field, North Sea	Maupin,
Corr, Michael E.	'Satellite Gravity Data and Lithospheric Stresses'	Minakov, Gaina
Gebreanenia, Alemayo	**The crust and upper mantle structure of the Afar region from 3D gravity inversion. Completed in June 17**	**Gaina, Minakov**
Gilje, Kristina	Interpreting the statistics of small craters on Mars by coupling cratering statistics and numerical modelling	Werner, Prieur
Hatalova, Petra	Guiding of Tectonic Plate Motions by Transform Faults	Conrad
Kolstad, Kristian G.	Relative relocation of earthquakes along the northern North Atlantic Ridge using Rayleigh waves	Maupin
Guren, Marthe G.	**Ab initio molecular dynamics simulations of melting phase relations in the system CaO-MgO-SiO2 at pressures of the Earth's lower mantle. Completed in June 17.**	**Mohn, Trønnes**
Karlsson, Rebecca	Rifting on Venus: Insights from Beta Regio system	Werner
Quintela, Orlando	Structural geology and tectonic history of the Caledonian "mèlange" near Lesja, Central-South Norway	TB Andersen, Jakob
Myhre, Ragnhild	Identification of seismic records left by different landslide types in Norway	Maupin

Visiting students / internships

Name	Home instituttion	CEED superv.	When
Bebyn, Alysse	University of Breteagne, France	Conrad	April-June
Hartmann, Robert	Exchange student		1.8.17 to 31.12.17
Kristiensen, Marthis G.	Erasmus Exchange student from Aarh\us University.	Maupin	August 16 to June 17
Wang, Kaiming	Institute of Geophysics, China Earthquake Administration. Visiting PhD studnent,	Maupin	Sept 17 to sept 18.

Conferences and workshops (co-)organized by CEED

Date	Title	Organizer(s)
6-9.6	FORM - From Orogens to Rifted Margins and Back: The formation and deformation of continental margins through Wilson Cycles. in St. Florent, Corsica.	**Gaina, Magni, Gørbitz ,Jakob.**
27-31.8	NetherMod: XV International Workshop on Modelling of Mantle and Lithosphere Dynamics. Putten, The Netherlands.	Co-organized by CEED
22.8	Conceiving Earth Evolution and Dynamics: A seminar in honour of Professor Trond H. Torsvik. The Academy of Science	**Gaina** and CEED
30.9 - 7.10	The 8th Nordic Paleomagnetism workshop. Hella, Iceland	**Torsvik,** Pesonen, Brown
17-19.10	CEED - Conceiving Earth Evolution and Dynamics. In University of La Laguna, Tenerife North.	**Gaina, Gørbitz, Conrad, Doubrovine, Faleide.**
1-3.11	EPOS-N Solid Earth Science Forum Workshop, Bergen. To test e-infrastructure developed by the EPOS project.	**Maupin** and collaborators

Field excursion at Corsica during the FORM conference in June 2017.

Labwork, workshops attended outside UiO		
Date	**Event**	**Attendant(s)**
18-24,1	Emerging Leaders/Arctic Frontiers , Tromsø, Norway	Shephard, Straume
January-February	Lab work in Geneva, Switzerland	Augland
5-8.3	Tel Aviv FLOWS workshop to fluids seepage and transform faulting in the dead Sea and Sea of Galilee and gas seepage	Mazzini
13-16.3	3rd CASE Workshop, BGR, Hannover, Germany	Shephard
May	Deep Carbon Observatory Moscow Workshop, Moscow, Russia	Conrad
9-13.5	Heat and Fluid Flow Modelling Training School, Devon, UK	Zaputlyaeva
6-16.6	Bubbles 2017 International Training School, UiT, Tromsø, Norway	Zaputlyaeva
30.5-4.6	Arctic Ocean 2016 workshop, Stockholm University, Sweden	Shephard
18-27.6	Island, NORVULK summer school.	Kjøll,
10-14 .7	3rd TIDES Advanced Training School: Seismic Tomography: Theory, Results, Uncertainties. Wolfson College, Oxford (UK)	Maupin
2.7-10.8	Samples processing and analyses at the laboratories of Istituto Nazionale di Geofisica e Vulcanologia (INGV) Palermo, Italy	Zaputlyaeva
2-24.8	Lake Baikal cruise: (seafloor sampling and acoustic investigations of gas seeps, flares, mud volcanoes, slumps and debris flows, canyons	Mazzini
14.8-1.9	Samples processing and analyses at the laboratories of Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) , Hannover Germany	Zaputlyaeva
18.9-18.10	Manoa, Hawaii	Heimdal
Septem-ber	4D-Deep Earth Science Meeting, Noordwijk, Netherlands	Conrad, Gaina
8-12.10	Granada FLOWS workshop to discuss transform faults and fracture zo-nes and related fluids migration	Mazzini
28-29.11	Workshop Grenoble (France) : Marginal plateaus: from magmatic diver-gent margins to transform margins, and from the continental shelf to the pelagic and contouritic setting	Breivik
26.8-2.10	Stockholm, ion probe at Nordsim	Callegaro
9-13.7	Raman spectroscopy	Callegaro

Field work in Norway		
2-9.5	Student field course in Western Norway	TB Andersen, J.Jakob
22-23.5	Holsenøy (with H.J. Kjøll, Timm John, Loic Labrousse, Sascha Zertani)	TB Andersen,
30-31.5	Kongsberg	Callegaro
June	Jotunheimen and Bergen-Lindås	Jakob
July	with Geoffroy Mohn and Pierre Closset: Sel and Vågå , Aursjøen, Gautsjøen, Sjongsæter, Lesja-Dovre-Dombås	Jakob
7-31.8	Tärnaby, Sarek, Kebnekaise, Indre Troms (with Loic Labrousse)	TB Andersen, H.J. Kjøll
August-Sept.	A field trip from Vågåmo to Røros	Jakob, van den Broek
Sept.	The Oslo area	Augland
Field work in Europe outside Norway		
Sept.	Orkenøyene	Augland
Sept.	Graubünden, Swiss Alps on a field trip lead by Geoffroy Mohn	Jakob, Kjøll
July	Geomagnetic field work in	Kulakov, Doubro-vine, Silkoset, Werner
July-August	Fur, Denmark	Jones, Stokke

Field work at Orkenøyene, photo: Lars Eivind Augland

Field work outside Europe		
15.3-4.4	Indonesia Fieldwork: Sampling of noble gasses from gas and oil fields around Lusi and the hydrothermal springs, drone sampling of Lusi crater	Mazzini, Zaputlyae-va
15-24.3	Dharwar craton, India . Field work	Corfu
15.3-4.4	Sampling of noble gasses from gas and oil fields around Lusi and the hydrothermal springs, drone sampling of Lusi crater	Mazzini
14-20.9	Israel fieldwork in the Sea of Galilee to sample hydrothermal and fresh springs, deploy seismometers network and conduct offshore geophysical survey	Mazzini
27.9-7.10	Brazil Filed work and marine expedition: Fieldwork in the Saco do Mamanguá, Rio de Janeiro, investigating and sampling offshore gas seeps	Mazzini

Adriano Mazzini and Alexandra Zaputlyaeva sampling the Lusi mud volcano in Indonesia.

Project funding

UiO project #	RCN-projects with number, project leader	kkr
SFF 143906		32 248
133899	235058 CraterClock, Werner	2 475
143997	226214/F50 National Geomagnetic lab, Torsvik	250
144151	246929/F20 Clim-VoTe, ISP-Geofag, Niscancioglu	281
190647	234153/E30 BarPz, Faleide	550
144251	249040/F60 DEEP Research school, Werner	2 759
144252	250327 Hyperextension, TB Andersen	1 699
144312	250111 600 Myr Plate Model, Domeier	1 547
144256	254962 Basement and Depostitional Systems, Faleide	1 646
144446	261729 Changes at the Top of the World, Gaina	1 500
144450	263000 Ashlantic, Jones	1 230
190645	268094/E10 The Future is Now, Svensen	52
RCN projects	**Total (excluding the SFF projects)**	**13 989**
650129	Lusi Lab ERC start up grant, Mazzini	1 436
651025	Subitop, Gaina	551
651021	PTAL, Werner	1 074
690471	3D Earth, Gaina	788
690477	Cratering Rates on Moon and Mars, Werner	826
EU&ESA projects	**Total**	**4 675**
421048	Chronos Det Norske&Lundin&Eni, Stein/Hannah	365
430369	BarIce Det Norske, Medvedev	990
430386	The 2017 Arctic Plate Reconstruction, Gaina	173
461349	Shephard, G. VISTA, Salary and running costs	571
Industry projects	**Total**	**2 183**
143906-913809	GoNorth SINTEF, Faleide	165
Other national funds	**Total**	**165**
UiO funding	Strategy grant	2 000
UiO funding	5 PhD positions incl. Running costs	3 695
UiO funding	Salary paid by UiO (not PhD-pos).	6 350
500-103601	Desktop, Conrad/Heeremans USIT funding	250
Other UiO funding incl.	overhead from other projects and the SFF	17 736
UiO funding	PES	36
UiO accounting	**Total**	**30 067**

Invited guest lectures at CEED

1. Mediterranean detachment zones: thermicity vs heritage. Dec. 7, by **Loic Labrousse** From UPMC, ISTeP, Paris
2. Geostatistical analysis and modeling of fault zones. - Dec. 5, by **Dmitriy Kolyukhin** From Trofimuk Institute of Petroleum Geology and Geophys; Novosibirsk, Russia
3. The selenium isotope perspective on marine and atmospheric redox perturbations - Nov. 30, by **Eva Stüeken** From University of St Andrews, UK
4. How plate tectonics was started and what controls its evolution? - Nov. 23, by **Stephan Sobolev** From GFZ, Potsdam and University of Potsdam
5. Earth's early magnetic field: Core processes and planetary habitability - Nov. 16, by **John A. Tarduno** From Earth and Environmental Sciences and Department of Physics and Astronomy, University of Rochester, USA
6. Kilometer-sized Cones on Mars: Igneous or Mud Volcanoes? - Nov. 9, by **Petr Broz** From Institute of Geophysics, The Czech Academy of Science, Prague
7. The growth of Earth's earliest continental crust - Nov. 2, -by **Jeff Vervoort** - From School of Environment, Washington State University
8. Understanding close encounters between small bodies and planets Oct. 26, by **Giovanni Valsecchi** From Istituto Nazionale di Astrofisica (INAF), Rome, Italy
9. Small grains are stronger: Resolving 40 years of debate on the strength of the lithosphere - Oct. 5, by **Lars Hansen** From Department of Earth Sciences, Oxford, UK
10. Reconstructing Last Interglacial sea level on a deforming Earth - Oct. 2, by **Jacqueline Austermann** From Department of Earth Sciences, Cambridge, UK
11. Beyond the crust: the role of the mantle in plate tectonic processes - Sep. 28, by **Philip Heron** From Department of Earth Sciences, Durham University, UK
12. Testing new ideas on the time-integrated tectonic evolution of the Earth: A geochemical approach - Sep. 21, by **Mihai Ducea** From Department of Geosciences, Univ. of Arizona,
13. Anisotropy of magnetic susceptibility - an efficient technique of structural analysis of rocks - Sep. 13, by **František Hrouda** Professor in Petrology and Structural geology,University of Praha 2, Czech Republic
14. Links between Climate and Erosion - Sep. 7, by **Niels Hovius** From GFZ, Helmholtz Centre Potsdam, Germany
15. **The CEED Wilson lecture 2017: Reverse Gaia Hypothesis: Life as a Geological Process - Aug. 18, The Science Library, Vilhelm Bjerknes' hus, Blindern Professor John Hernlund from the Earth-Life Science Institute (ELSI), Tokyo Inst. of Technology**.
16. Global seismic tomography using teleseismic and core-diffracted body waves - May 11, by **Kasra Hosseini** From Department of Earth Sciences, University of Oxford, UK
17. From planetary boundaries to ecosystem services: Guiding development on a changing planet. May 4, by **Elena Bennett**, Natural Resource Sci. and McGill School of Envirom.
18. The 13 million year Cenozoic pulse of the Earth - Apr. 20, by **Vadim Kravchinsky** From University of Alberta, Canada; Northwest University, Xi'an, China

19. Glacial alteration of volcanic terrains: A chemical and mineralogical investigation of the Three Sisters, Oregon, USA - Apr. 7, by **Alicia Rutledge** From Purdue University

20. Observation of volcanic degassing using ground-based imaging methods - Apr. 6, by **Jean -François Smekens** From Laboratoire Magmas et Volcans, Université Blaise Pascal, Clermont-Ferrand

21. The bombardment of the Moon and the early evolution of the Solar System - Mar. 30, by **Alessandro Morbidelli** From Observatoire de la Côte d'Azur, Nice, France

22. Oceanic microplate formation and the India-Eurasia collision - Mar. 23, by **Kara Matthews** From University of Oxford, UK

23. Seismic evidence of spatially variable magmatic crustal accretion during the opening of the Tyrrhenian back-arc basin - Mar. 16, by **Manel Prada** From Dublin Institute for Advanced Studies, Ireland

24. Intrusive or extrusive mafic magma, what is more important for triggering mass extinctions? A case study from the Central Atlantic Magmatic Province (CAMP) - Mar. 9, by **Joshua Davies** From University of Geneva, Genève

25. **Carbon sources during the Paleocene-Eocene Thermal Maximum - Feb. 23, by** Joost Frieling From Utrecht University

26. New insights into the formation history and surface chemistry of Mars - Feb. 17, - - by **Jeremy Bellucci** From Swedish Museum of Natural History, Stockholm

27. Provenance and weathering of Eocene sediments from the Central Basin, Svalbard - Feb. 16, by Ruth Hindshaw From University of Cambridge, UK

28. Thermal evolution of the Earth and secular intermittent layering - Feb. 9, by **Carolina Lithgow-Bertelloni** From UCL, London

29. How Heterogeneous is the Earth's Mantle? Combining New Observations from Seismology with Geochemistry and Geodynamics Feb. 2, by **Nicholas Schmerr** From University of Maryland

30. (De)compaction waves in porous viscoelastoplastic media and focused fluid flow - Jan. 26, by **Viktoriya Yarushina** From Institute for Energy Technology, Lillestrøm

From the CEED Wilson lecture in 2017 by John Hernlund.

Scientific publications (red: high impact journals, 13 out of 117 ***: young scientists)**

1. Aarseth, Iselin; Mjelde, Rolf; Breivik, **Asbjørn Johan; Minakov, Alexander; Faleide, Jan Inge;** Flueh, Ernst R. & Huismans, Ritske (2017). Crustal structure and evolution of the Arctic Caledonides: Results fromcontrolled-source seismology. Tectonophysics. ISSN 0040-1951. 718, s 9- 24

2. ***Abdelmalak, M.M., Faleide, J.I., Planke, S.,** Gernigon, L., Zastrozhnov, D., **Shephard, G.E.,** Myklebust, R., 2017. The T-Reflection and the deep crustal structure of the Vøring Margin offshore mid-Norway. Tectonics, 2017TC004617.

3. ***Angkasa, Syahreza Saidina; Jerram, Dougal Alexander**; Millett, John M; **Svensen, Henrik; Planke, Sverre;** Taylor, Ross A; Schofield, Nick & Howell, John (2017). Mafic intrusions, hydrothermal venting and the basalt-sediment transition: Linking onshore and offshore examples from the North Atlantic igneous province. Interpretation, ISSN 2324-8858. 5(3). doi: 10.1190/int-2016-0162.1

4. Artemieva I.M., **Thybo H.,** Jakobsen K., Sorensen N.K., Nielsen L.S.K. , 2017, Heat production in granitic rocks: Global analysis based on a new data compilation GRANITE2017, Earth-Science Reviews, vol.172, pp.1-26

5. Ashwal, Lewis D.; Wiedenbeck, Michael & **Torsvik, Trond Helge** (2017). Archaean zircons in Miocene oceanic hotspot rocks establish ancient continental crust beneath Mauritius. Nature Communications. ISSN 2041-1723. 8 . doi: 10.1038/ncomms14086

6. ***Augland, Lars Eivind**; Moukhsil, Abdelali & Solgadi, Fabien (2017). Mantle influence of syn-to late Grenvillian alkaline magmatism in the Grenville Province: causes and implications. Canadian journal of earth sciences, ISSN 0008-4077. 54(3), s 263- 277. doi: 10.1139/cjes-2016-0135

7. Banks, Maria E.; **Xiao, Zhiyong**; Braden, Sarah E.; Barlow, Nadine G; Chapman, Clark R.; Fassett, Caleb I.; Marchi, Simone S. Revised constraints on absolute age limits for Mercury's Kuiperian and Mansurian stratigraphic systems. Journal of Geophysical Research - Biogeosciences 2017 ;Volum 122.(5) s. 1010-1020

8. ***Baron, Marzena Anna**; Lord, Oliver T.; Myhill, Robert; Thomson, Andrew R.; Wang, Weiwei; **Trønnes, Reidar G**. & Walter, Michael J. (2017). Experimental constraints on melting temperatures in the MgO–SiO2 system at lower mantle pressures. Earth and Planetary Science Letters. ISSN 0012-821X. 472, s 186- 196. doi: 10.1016/j.epsl.2017.05.020

9. Blaich, Olav Antonio; Tsikalas, Filippos & **Faleide, Jan Inge** (2017). New insights into the tectono-stratigraphic evolution of the southern Stappen High and its transition to Bjørnøya Basin, SW Barents Sea. Marine and Petroleum Geology. ISSN 0264-8172. 85, s 89-105 . doi: 10.1016/j.marpetgeo.2017.04.015

10. Blischke, A; **Gaina, Carmen**; Hopper, J.R.; Péron-Pinvidic, Gwenn; Brandsdóttir, Bryndís; Guarnieri, P; Erlendsson, Ögmundur; Gunnarsson, K. The Jan Mayen microcontinent: an update of its architecture, structural development and role during the transition from the Ægir Ridge to the mid-oceanic Kolbeinsey Ridge. Geological Society Special Publication 2017 ; Volum 447.(1) s. 299-337

11. Bredow, Eva; **Steinberger, Bernhard**; Gassmöller, René & Dannberg, Juliane (2017). How plume-ridge interaction shapes the crustal thickness pattern of the Reunion hotspot track. Geochemistry Geophysics Geosystems. ISSN 1525-2027. 18(8), s 2930- 2948 . doi: 10.1002/2017GC006875

12. **Breivik, Asbjørn Johan; Faleide, Jan Inge;** Mjelde, Rolf; Flueh, Ernst R. & Murai, Yoshio (2017). A new tectono-magmatic model for the Lofoten/Vesterålen Margin at the outer limit of the Iceland Plume influence. Tectonophysics. ISSN 0040-1951. 718, s 25-44 . doi: 10.1016/j.tecto.2017.07.002

13. ***Callegaro, Sara**; Andrea Marzoli, Herve´ Bertrand; Janne Blichert-Toft; Laurie Reisberg; Giancarlo Cavazzini; Fred Jourdan; Joshua H. F. L. Davies; Laura Parisio; Romain Bouchet; Andre Paul; Urs Schaltegger and Massimo Chiaradia (2017) Geochemical Constraints Provided by the Freetown Layered Complex (Sierra Leone) on the Origin of High-Ti Tholeiitic CAMP Magmas. Journal of Petrology, 2017, Vol. 58, No. 9, 1811–1840.

14. ***Collignon, Marine; Mazzini, Adriano**; Schmid, Daniel Walter; Lupi, Matteo. (2017) Modelling fluid flow in active clastic piercements: challenges and approaches. Marine and Petroleum Geology, in press with 2017.

15. **Conrad, Clinton Phillips; Selway, K.;** Hirschmann, M.M.; Ballmer, M.D. & Wessel, P. (2017). Constraints on volumes and patterns of asthenospheric melt from the space-time distribution of seamounts. Geophysical Research Letters. ISSN 0094-8276. 44(14), s 7203-7210 . doi: 10.1002/2017GL074098

16. Corseri, Romain; Senger, Kim; **Selway, Katherine; Abdelmalak, Mohamed Mansour; Planke, Sverre** & **Jerram, Dougal Alexander** (2017). Magnetotelluric evidence for massive sulphide mineralization in intruded sediments of the outer Vøring Basin, mid-Norway. Tectonophysics. ISSN 0040-1951. 706-707, s 196- 205 . doi: 10.1016/j.tecto.2017.04.011

17. ***Crameri, Fabio (2017).** Planetary Tectonics: Sinking plates on Venus. Nature Geoscience. ISSN 1752-0894. 10, s 330- 331 . doi: 10.1038/ngeo2941

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"Captain on Planet Earth" ***Trond H. Torsvik*** *was interviewed by Titan.no as the 2017 Arthur Holmes` medalist. Photo: Gunhild M. Haugnes/UiO*

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Twitter accounts disseminating CEED research

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62. **The DEEP twitter account** DEEP Research School@ResearchDEEP - a national research school in geosciences for dynamics and evolution of earth and planets. DEEP aims to educate solid earth and planetary scientists. - 37 enteries in 2017

63. Aswin Sekhar@aswinsek - Scientist+Speaker+Science Writer. Retweets & views NOT from employer or spouse or anyone else! :)

64. Bultel Benjamin@bultel_eMars - eMars Team member PhD Student It's all about rock...

65. Dr Volcano@dougalearth - DougalEARTH AKA Dr. Volcano, earth scientist. I am interested in all aspects of the great planet, its rocks and landscapes!!

66. Grace Shephard@ShepGracie - Geodynamics, tectonics, Arctic and oceans

67. Hans Jørgen Kjøll@hans_j_k - Ph.D. student at the Center for Earth Evolution and Dynamics at University of Oslo. Working with continental break-up (volcanoes and stuff)

68. Henrik H. Svensen@henriksvensen - Geologiforsker (Univ. Oslo) og sakprosaforfatter. Research Professor in geology (mass extinctions), and writer.

69. Hope Hahren@HopeJahren - author of LAB GIRL, winner of the 2016 NBCC award in autobiography 70. Johannes Jakob @JoJakGeo - Postdoc at the Centre for Earth Evolution and Dynamics at the University of Oslo. I work on plate tectonics – a lot of it is schist, to be

honest. 71. Király Ágnes @agi_a_kiraly

72. Morgan Jones@geomorganjones - volcanologist/geochemist working at CEED, expertise is the interaction between volcanic terrains and the climate 73. Nils Charles Prieur@nilscp - French, norwegian, civil engineer, hydrologist, basketball player and now planetary scientist 74. sruthi uppalapati@sruthisruthi

75. Susanne Buiter@susannebuiter - Researcher at the Geological Survey of Norway @nguweb and at Uni Oslo @CEEDOslo. Programme Committee chair #EGU18 @EuroGeosciences

76. Valentina Magni@valentinamagni

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84. **Sekhar, Aswin**. Stoned Earth. Telegraph India today, 23. October.

85. **Sekhar, Aswin.** Recent Total Solar Eclipse & Scope for Citizen Science Projects. The Telegraph, 28. August.

86. **Sekhar, Aswin**. Easier to Travel to Space Than to Conferences! The Quint Magazine, India. August.

87. **Shephard, Grace**. Adgang til underverden - Atlas to the Underworld. Interview about the New seismic atlas based on tomography, by the Danish Weekendavisen, 24 November 2017.

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Aerial view of the famous Rapa valley in Sarek nationalpark, Sweden. Photo: Hans Jørgen Kjøll

Abstracts (talks & posters at conferences)

1.**Abdelmalak, M.M. Planke, S.** & **Faleide, J.I.** Breakup-related igneous rocks on the mid-Norwegian margin. NGF Abstracts and Proceedings, no. 1, p. 11.
2.**Abdelmalak, M.M; Sverre Planke**, Stephane Polteau, Reidun Myklebust. Tertiary volcanism in the NW Atlantic area: update on the repartition and Age. European Geoscience Union (April, poster).
3. **Afonso, Juan Carlos;** Nicholas Rawlinson, Yingjie Yang, Sergio Zlotnik, and Olga Ortega. EGU - 18505 (Poster) Linking geodynamics and geophysical inversion with multi-observable probabilistic tomography. Mon, 24 Apr.

4. **Andersen, Torgeir Bjørge**. Corsican Adventures: discovery of subduction related earthquake fault-rocks. 70 years with Håkon Austrheim. 12-06.

5. **Andersen, Torgeir Bjørge**. The FORM Conference: Concluding Remarks. The FORM conference: From Orogens to Rifted Margins and back. 06-05.

6. **Andersen, Torgeir Bjørge**. Trond Helge Torsvik turns 60; The Early Days. Conceiving CEED: a seminar in honour of Trond H Torsvik; 09-22.

7. **Andersen, Torgeir B.** Corsican Adventures: discovery of subduction related earthquake fault-rocks. 70 years with Håkon Austrheim; DNVA 2017-12-06 - 2017-12-06

8. **Andersen, Torgeir Bjørge; Jakob, Johannes; Kjøll, Hans Jørgen; Corfu, Fernando; Planke, Sverre; Torsvik, Trond Helge**; Tegner, Christian; Labrousse, Loic. The Pre-Caledonian Margin of Baltica. The CEED conference: Conceiving Earth Evolution and Dynamics. 10-17 to 10-20.

9. **Andersen, Torgeir B; Jakob, Johannes; Kjøll, Hans Jørgen; Corfu, Fernando**; Tegner, Christian. A new look at the pre-Caledonian margin of Baltica. NGF Winter meeting. 9-11 Jan.

10. **Andersen, Torgeir Bjørge; Jakob, Johannes; Kjøll, Hans Jørgen; Corfu, Fernando**; Tegner, Christian; Mohn, Geoffroy; Labrousse, Loic; **Planke, Sverre; Abdelmalak, Mohamed Mansour**. The Magma-poor and Magma-rich settings; the onshore perspective: The Caledonian case. Pontresina Workshop: IMagin Rifting. 09-24 to 09-29.

11. **Andersen, Torgeir Bjørge; Kjøll, Hans Jørgen; Jakob, Johannes; Corfu**, Fernando; Tegner, Christian. The pre-Caledonian margin of Baltica. EGU 04-23.

12. Artemieva, Irina; Barantseva, Olga; Thybo, Hans; Shulgin, Alexey A; Makushkina, Anna. Lithosphere Structure of the North Atlantic Region. Geological Soc. America; 2017-10-21 - 2017-10-27

13. Baig, I**. Faleide, J.I**. Hjelstuen, B.O. Sejrup, H.P. Nystuen, J.P. Aagaard, P. Jahren, J. & Mondo,N.H. Seismic mapping of Quaternary sediment distribution in the central and northern North Sea. NGF Abstracts and Proceedings, no. 1, p. 15.

14. Baig, I. **Faleide, J.I**. Jahren, J. & Mondol, N.H. Burial and exhumation history controls on shale compaction and thermal maturity along the Norwegian North Sea margin. NGF Abstracts and Proceedings, no. 1, p. 15.

15. **Baron, Marzena Anna**; Lord, OT; Myhill, R; Thompson, AR; Wang, W; **Trønnes, Reidar G** & Walter, MJ. Eutectic melting in the MgO-SiO2 system and its implication to Earth's lower mantle evolution. Trans. Am. Geophys. Union, Fall Meeting, MR21C-06.

16. **Baron, Marzena Anna;** Lord, OT; Myhill, R; Thielmann, M; Thompson, AR; Wang, W; **Trønnes, Reidar G**; Walter, MJ. Eutectic melting in the MgO-SiO2 system and its implication to Earth's

lower mantle evolution. High-Pressure Mineral Physics Seminar (HPMPS-9) Saint Malo, France, Progr. Abstr. 85-86

17. **Baron, Marzena Anna**; Walter, MJ; Siebert, J; Badro, J; Drewitt, JWE; Lord, OT; Louvel, M; Lyubomirskiy, M & **Trønnes, Reidar G**. Magma ocean thermometry, using metal-silicate partitioning of germanium. ACCRETE Workshop on Accretion and Early Differentiation of the Earth and Terrestrial Planets, Nice.

18. Bellwald, Benjamin, **Sverre Planke**, Mohammed Matar, and Emilia Daria Piasecka. EGU -12990 (Poster) P-Cable 3D high-resolution seismic data as a powerful tool to characterize subglacial landforms and their genesis: A case study from the SW Barents Sea. Fri, 28 Apr.

19. Bingen, Bernard; Seydoux-Guillaume, A.-M.; Corfu, Fernando; Whitehouse, Martin J.; Bosse, V.; Müller, Axel; Guillaume, D. Low temperature alteration of monazite phenocrysts in pegmatite: a general feature. Goldschmidt2017 Conference; 2017-08-13 - 2017-08-18

20. Blischke, A; Ö. Erlendsson, B. Brandsdóttir, M.S. Stoker, **C. Gaina**, Volcanic systems and structural styles along fracture zones in the central Northeast Atlantic, possible analogue applications for Iceland, JFI Workshop, 17 November 2017, Faroe Islands (Talk).

21. Boudinier, G; P. Wessel, and **C.P. Conrad**, "Plume-spotting: Deriving the absolute motion of hotspots and plates", GSA Cordilleran Section Meeting, Honolulu, HI, May.

22. **Breivik, Asbjørn Johan; Faleide, Jan Inge**; Mjelde, Rolf; Flueh, Ernst R. & Murai, Yoshio . Origin of the Vøring Plateau, offshore Norway – interplay between timing of rifting and emplacement of plume material. Marginal plateaus; 2017-11-28 to 29.

23. **Breivik, Asbjørn Johan; Faleide, Jan Inge**; Mjelde, Rolf; Flueh, Ernst R. & Murai, Yoshio . The Transition from Volcanic to Rift Dominated Crustal Breakup – From the Vøring Plateau to the Lofoten Margin, Norway. AGU Fall Meeting; 2017-12-11 to 15.

24. **Buiter, Susanne** and Susan Ellis. EGU -4832 | Posters . The challenges of numerically simulating analogue brittle thrust wedges. Wed, 26 Apr.

25. **Buiter, Susanne**. EGU -8421 (Poster) How collisional inheritance can affect rifted margin architecture. Thu, 27 Apr.

26. **Bultel B.,** Métayer R., **Werner S.,** Apollo Landing Sites 16 and 17: Spectral Mapping and Crater Statistics Reevaluated, Lunar and Planetary Science Conference 48th, Houston.

27. Burchardt, Steffi; Palma, Octavio; Galland, Olivier; Mair, Karen; **Jerram, Dougal A.** Syn-emplacement deformation of the Cerro Bayo laccolith, Argentina. IAVCEI Scientific Assembly; 2017 -08-14 to 18.

28. **Callegaro, S.** Baker, D.R. Marzoli, A. Whitehouse, M. De Min, A. & **Svensen, H.H.** Sulfur partitioning between clinopyroxene and basaltic melts: using clinopyroxenes as probes for volatiles budget in magmas from the past. NGF Abstracts and Proceedings, no. 1, p. 18.

29. Celli, N.L; Sergei Lebedev, Andrew Schaeffer, Matteo Ravenna, and **Carmen Gaina**, Imaging the lithosphere and underlying mantle of the South Atlantic, South America and Africa using waveform tomography with massive datasets, S43G-06, American Geophysical Union Fall Meeting, 11-15.12.2017, New Orleans, USA (Talk).

30. **Collignon, Marine**; Daniel W. Schmid, Christophe Galerne, Matteo Lupi, and **Adriano Mazzini**. EGU -4793 (Oral) Modelling fluid flow in clastic eruptions: application to the Lusi mud eruption. Fri,

28 Apr.

31. **Collignon, Marine**; Øyvind Hammer, **Mohammad J. Fallahi**, Matteo Lupi, Daniel W. Schmid, **Husein Alwi**, Soffian Hadi, and **Adriano Mazzini**. EGU -4822 (Poster)Linking the Lusi mud eruption dynamics with regional and global seismic activity: a statistical analysis. Fri, 28 Apr.

32. **Conrad, Clinton P.** Addressing Outstanding Problems in Deep Earth Dynamics Using Data and Models. 4D-Deep Earth Science Meeting; 2017-09-27 (TalK)

33. **Conrad, Clinton P**. The deep carbon cycle and mantle-lithosphere dynamics: Looking backward from today. Deep Carbon Observatory Workshop; 2017-05-24 (Talk)

34. **Conrad, C.** Tectonic Reconstructions of Dynamic Topography and Sea Level. Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

35. **Conrad, C.P. B. Steinberger, T.H. Torsvik**, "Sea Level Change due to Time-Dependent Long-Wavelength Dynamic Topography Inferred from Plate Tectonic Reconstructions", EGU General Assembly, Vienna, Austria, April.

36. **Conrad, Clinton P;** Lars N. Hansen. EGU -9841 Orals. Interplay between Tectonic Plate Motions, Anisotropic Viscosity, and the Development of Rock Fabrics in the Asthenosphere. 27 Apr.

37. **Conrad, Clinton P; Domeier, M**. Tracing the edges of the LLSVPs in the spatial distribution of seamount volcanism. Conceiving Earth Evolution and Dynamics; 2017-10-16 (Oral)

38. **Conrad, Clinton P.** & Hansen, L. Interplay between Tectonic Plate Motions, Anisotropic Viscosity, and the Development of Rock Fabrics in the Asthenosphere. EGU General Assembly; 2017-04-24 (Oral)

39. **Conrad, Clinton P**. Addressing Outstanding Problems in Deep Earth Dynamics Using Data and Models. 4D-Deep Earth Science Meeting; 2017-09-27 (Oral)

40. **Conrad, Clinton P.** The deep carbon cycle and mantle-lithosphere dynamics: Looking backward from today. Deep Carbon Observatory Workshop; 2017-05-24 (Oral)

41. **Conrad, Clinton P; Selway, K.**; Hirschmann, M.M.; Ballmer, M.D. & Wessel, P. Constraints on volumes and patterns of asthenospheric melt from the space-time distribution of seamounts. Nethermod 2017; 2017-08-27 (Oral).

42. Conrad, Clinton P; Watkins, C.E.; Steinberger, B.; Torsvik, T.H. Misshapen Earth: Inferring dynamic topography from bathymetry and plate motions. Nethermod 2017; 2017-08-27

43. **Conrad, Clinton P; Steinberger, B; Torsvik, T.H.** Tectonic reconstructions of dynamic topography and sea level. Conceiving Earth Evolution and Dynamics; 2017-10-16 (Oral):

44. **Conrad, Clinton P**; Watkins, C.E.; **Steinberger, B.** & **Torsvik, T.H**. Misshapen Earth: Inferring dynamic topography from bathymetry and plate motions. Nethermod 2017; 2017-08-27.

45. **Corfu, F.** The Jotun Nappe Complex and its relations to surrounding allochthons. Int. Meeting: The formation and deformation of continental margins through Wilson Cycles. 6-9 June 2017, Corsica.

46. **Corfu, Fernando; Larsen, B.T;** Ganerød, M.; Heyer, H. & Dahlgren, Sven. Towards a high resolution U-Pb temporal framework for the Oslo Graben. 14th SGA Biennial Meeting; 2017-08-20 to 23.

47. Corfu, Fernando; Larsen, B.T.; Ganerød, M.; Heyer, H.; Dahlgren, Sven. Towards a high resolution U-Pb temporal framework for the Oslo Graben. 14th SGA Biennial Meeting; 2017-08-20 - 2017-08-23

48. **Crameri, F.** Abrupt Upper-Plate Tilting During Slab–Transition-Zone Collision. Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

49. **Crameri, Fabio**. EGU -8528 (Poster) StagLab: Post-Processing and Visualisation in Geodynamics I Wed, 26 Apr.

50. **Crameri, Fabio;** Carolina Lithgow-Bertelloni; Paul Tackley. EGU -13862 (Oral). The dominant surface-topography contributions of individual subduction parameters. Wed, 26 Apr.

51. Dangendorf, S; M. Marcos, G. Wöppelmann, **C.P. Conrad,** T. Frederiksen, and R. Riva, "A reconciled estimate of twentieth century global mean sea-level rise", Regional Sea Level Changes and Coastal Impacts, New York, NY, July .

52. Dangendorf, S; M. Marcos, G. Wöppelmann, **C.P. Conrad**, T. Frederiksen; R. Riva, "A reconciled estimate of 20th century global mean sea-level rise", EGU General Assembly, Vienna, Austria, April.

53. **Domeier, M.** Plate tectonic modelling in pre-Jurassic time. . Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

54. **Domeier, Mat**. EGU -10167 (Oral) Early Paleozoic tectonics of Asia: A preliminary full-plate model. Thu, 27 Apr.

55. **Domeier, Mat**. Plate tectonic modelling in pre-Jurassic time. 8th Nordic Paleomagnetism Workshop, Iceland 30.9 to 7.10 (Invited talk)

56. Døssing, Arne; **Carmen Gaina;** John Brozena. EGU -12107 (Oral). Building and breaking a Large Igneous Province: An example from the High Arctic. Mon, 24 Apr.

57. **Doubrovine, P.** Estimating true polar wander from plate models. 8th Nordic Paleomagnetism Workshop, Iceland 30.9 to 7.10 (Invited talk)

58. **Doubrovine, P.** True polar wander according to Torsvik (and others). CEED: Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

59. **Doubrovine, Pavel V; Trond H. Torsvik; Mathew Domeier**. EGU -7794 (Poster). Paleomagnetism and paleosecular variation from the late Miocene to recent lavas of Mauritius. Thu, 27 Apr.

60. Døssing, A; **Carmen Gaina**, John Brozena, Building and breaking a Large Igneous Province: An example from the High Arctic, Geophysical Research Abstracts, vol 19, EGU2017-12107, EGU General Assembly, 23-28.04. 2017, Vienna, Austria (Talk).

61. Eibl, Eva P. S; Tómas Jóhannesson, Benedikt G. Ofeigsson, Matthew J. Roberts, Christopher J. Bean, Kristin S. Vogfjörd, **Morgan T. Jones**, Melissa A. Pfeffer, Baldur Bergsson, and Finnur Pálsson. EGU -17090 (Poster) Highlight. Geophysical Tracking of a Subglacial Flood in Near Real-Time. Mon, 24 Apr.

62. Eide, Christian Haug; Schofield, Nick; **Jerram, Dougal A;** Howell, John Anthony . Basin-scale architecture of deeply emplaced sill complexes. Norwegian Geological Winter Meeting; 2017-01-09 to 11.

63. Ershova, V; Ruslana Belyakova, Andrei Prokopiev, Andrei Khudoley, **Jan Inge Faleide, Carmen Gaina**, Nikolay Sobolev, Eugeniy Petrov, Basement composition and pre-Mesozoic sedimentary succession of northern Barents sea revealed by new data on Franz Josef Land Jurassic conglomerates, AAPG/SEG International Conference and Exhibition, October 15-18, 2017, London, UK (Talk).

64. **Faleide, J.I.** Comparing rifted margins in the South and North Atlantic with focus on along-margin structural and magmatic segmentation. Int. Meeting: The formation and deformation of continental margins through Wilson Cycles. 6-9 June 2017, Corsica

65. Faleide, Jan Inge. Barents shelf tectonic evolution – recent advances. Talking Trias 2017; 2017-10-25 - 2017-10-26

66. Faleide, Jan Inge. Cenozoic evolution of the western Barents Sea-Svalbard margin. CASE (Circum-Arctic Structural Events) Workshop; 2017-03-13 - 2017-03-16

67. Faleide, Jan Inge. Integrated Basin Studies – with examples from the Barents Sea. Petroleum Research School of Norway Annual PhD seminar; 2017-11-16 - 2017-11-16

68. Faleide, Jan Inge. Integrated Basin Studies – with examples from the Barents Sea. Petroleum Research School of Norway Annual PhD seminar; 2017-11-16 - 2017-11-16

69. Faleide, Jan Inge. Late Paleozoic-Mesozoic basin evolution in the SW Barents Sea – North Atlantic-Arctic links. CASE (Circum-Arctic Structural Events) Workshop; 2017-03-13 - 2017-03-16

70. **Faleide, J.I. Abdelmalak, M.M. Shephard, G.E. Torsvik, T.H. Gaina, C.** Tsikalas, F.1, Blaich, O.A., Planke, S.1, & Myklebust, R. Quantification and restoration of pre-drift extension across NE Atlantic conjugate margins. NGF Abstracts and Proceedings, no. 1, p. 22.

71. **Fallahi, Mohammad Javad**; Anne Obermann, Matteo Lupi; **Adriano Mazzini**. EGU -6531 (Oral) The feeding system of the Lusi eruption revealed by ambient noise tomography. Fri, 28 Apr.

72. **Fallahi, Mohammad Javad**; Matteo Lupi, **Adriano Mazzini**, Alina Polonia, Antonino D'Alessandro, Giuseppe D'Anna; Luca Gasperini. EGU -9981 (Poster) Mud volcano monitoring and seismic events along the North Anatolian Fault (Sea of Marmara). Fri, 28 Apr.

73. Fullea, Javier, Ana Negredo, María Charco, Imma Palomeras, Antonio Villaseñor, and **Juan Carlos Afonso**. EGU -10640 (Poster) The topography of the Iberian Peninsula from coupled geophysical-petrological inversion of multiple data sets. 28 Apr.

74. **Gabrielsen, Roy Helge; Faleide, Jan Inge**; Wong, P.W; Gac, Sebastien; Indrevær, Kjetil; Faisal Miraj, M.; Dinkgreve, Patricia; Sokoutis, Dimitrios & Pascal, Christophe. Palaeogene North Atlantic opening along the Barents Sea margin and its adjacent deformation. Winter conference 01-09 to 11.

75. Gac, Sebastien; Indrevær, Kjetil; **Gabrielsen, Roy Helge** & **Faleide, Jan Inge** . A model of the tectonic evolution of the Loppa High from Late Paleozoic to present-day. Winter conference -01-09 to 11.

76. **Gaina, C.** Microcontinents: Stories about complexities in the Wilson tectonic cycles. Int. Meeting: The formation and deformation of continental margins through Wilson Cycles. 6-9 June 2017, Corsica.

77. **Gaina, C**. Hot news from the cold Arctic: Crustal asymmetry and ultra-slow spreading in the Eurasia Basin revealed by new data, University of Tasmania, Australia, December 2017 (Invited talk).

78. **Gaina, C**. When plates change their course: Examples from Africa and North America, University of Utrecht, Netherlands, October 2017 (Invited talk).

79. **Gaina, C**. Hot news from the cold Arctic, University of Utrecht, Netherlands, July 2017 (Invited talk).

80. **Gaina, C.** From Black Sea to Arctic and Antarctic: An unplanned career, Dorothy Hill Symposium: Women in Geosciences, November 2017, Brisbane, Australia (Invited talk).

81. **Gaina, C.** A review of global marine magnetic anomalies at Eocene time, International Conference of Rock Magnetism, July 2017, Utrecht, Netherlands (Invited talk).

82. **Gaina, C;** Nicolas Luca Celli, Anett Blischke, Wolfram H. Geissler, Geoffrey S Kimbell and Sergei Lebedev, Seamounts and Oceanic Igneous Features in the Northeast Atlantic: A Link Between Plate Motions and Mantle Dynamics, ID# 203194, Chapman Conference, Submarine Volcanism: New Approaches and Research Frontiers, 29.01-03.02.2017, Hobart, Australia. (Poster).

83. Gasser, Deta; Tor Grenne; **Lars Eivind Augland**. EGU -4878 (Poster) TS7.5 The enigmatic Gula Complex of the central Norwegian Caledonides: new constraints on age and origin from zircon dating and geochemistry. Fri, 28 Apr.

84. Gelabert, Olga Ortega; Sergio Zlotnik, **Juan Carlos Afonso**, and Pedro Díez. EGU -11521 (Poster) GD8.4/EMRP4.10/TS8.7. Model Order Reduction for the fast solution of 3D Stokes problems and its application in geophysical inversion. Wed, 26 Apr,

85. **Gottschalk Ballo; Eirik, Lars Eivind Augland**, Øyvind Hammer, **Henrik Svensen**. EGU -15378 (Poster) A new age model for the Late Ordovician bentonites in Oslo, Norway. Tue, 25 Apr,. EGU -12418 (Poster) SSP2.4/GMPV1.5

86. **Guren, M.G; Mohn, Chris E; Trønnes, Reidar G**. Melting curves for periclase, bridgmanite and Ca-perovskite by ab initio molecular dynamics. Conceiving Earth Evolution and Dynamics, San Cristobal de La Laguna, Tenerife, Prog. Abstr. 36.

87. Haas, P; Jörg Ebbing, **Carmen Gaina**, Defining tectonic boundaries with satellite gravity gradient, DGG Conference, March 2017, Potsdam, Germany (Talk).

88. Hafeez, A., **Planke, S, Jerram, D.A.,** Millett, J.M.2, Maharjan, D.2 & Prestvik, T. Upper Paleocene ultramafic igneous rocks offshore mid-Norway: reinterpretation of the Vestbrona Formation as a sill complex. NGF Abstracts and Proceedings, no. 1, p. 30.

89. **Hannah, J; Stein, H.** Fifty Shades of Gray (and Black). NGF Abstr. and Proceedings, no. 1, p. 32.

90. **Hartz, E.H., Medvedev, S.,** Schmid, D.W., **Faleide, J.I.,** Skeie, J.E., & Iyer, K. Fire and Ice: Application of geodynamic thinking into petroleum system models. In: Petroleum Systems Modeling Workshop - Challenges of structurally complex basins, Paris, France, 15-16 June (invited talk)

91. Heim, Michael**; Fernando Corfu**. EGU -9151 | Posters Heidal revisited: new light on critical elements in the allochthon of the classical Otta region (Oppland). Fri, 28 Apr.

92. Heim, Michael; Corfu, Fernando. Heidal revisited: new light on critical elements in the allochthon of the classical Otta region (Oppland). 32nd Geological Winter Meeting; 2017-01-09 - 2017-01 -11

93. **Heyn, Björn Holger; Conrad, Clinton Phillips** & **Trønnes, Reidar G**. Stabilizing effect of a chemical viscosity contrast on LLSVP structures Abstr., Gordon Res. Conf. on Chemical and dynamical evolution of Earth's deep interior, from formation to today. Mount Holyoke College, South Hadley, MA. Invited Talk.

94. Heyn, B.; Conrad, Clinton Phillips; Trønnes, R. Stabilizing effect of a chemical viscosity contrast on LLSVP structures. Gordon Research Conf. 'Interior of the Earth'; 2017-06-02

95. **Husein, Alwi; Adriano Mazzini**, Matteo Lupi, Alessandra Sciarra, and **Karyono Karyono**. EGU -7160 (Poster) A geophysical and geochemical investigation of the Kalang-Anyar mud volcano, Indonesia. Fri, 28 Apr.

96. Incel, Sarah; Nadège Hilairet, Loïc Labrousse, **Torgeir B. Andersen**, Yanbin Wang, and Alexandre Schubnel. EGU -6669 (Poster) Eclogite-facies metamorphic reactions under stress and faulting in granulites from the Bergen Arcs, Norway: an experimental investigation. Mon, 24 Apr.

97. Indrevær, Kjetil; Gabrielsen, Roy Helge; Bugge, Aina Juell & Faleide, Jan Inge . Latest Permian/earliest Triassic folds & thrusts on the Loppa High. x

98. Indrevær, Kjetil; Gabrielsen, Roy Helge; Gac, Sebastien & **Faleide, Jan Inge**. Is there a tectonic signal in the development of the late Palaeozoic bioherms on the Loppa High? Winter conference, 01-09 to 11.

99. Indrevær, Kjetil; Gac, Sebastien; Gabrielsen, Roy Helge & Faleide, Jan Inge. Can metamorphic phase changes in the lower crust help explain the repeated uplift and subsidence of the Loppa High area through time? ARCEx Annual Conference , 05-10 to 11.

100. **Jakob, J.** Transitional crust in the fossil ocean-continent transition zone of the pre-Caledonian rifted margin of Baltica and its link to the Scandinavian Dyke Complex. Int. Meeting: The formation and deformation of continental margins through Wilson Cycles. 6-9 June 2017, Corsica.

101. **Jakob, J. Andersen, T.B.** Boulvais, P.2 & Beyssac, O.3 . Scandian metamorphism of metapelites and serpentinites in the pre-Caledonian magma-poor hyperextended margin of Baltica. NGF Abstracts and Proceedings, no. 1, p. 42.

102. **Jakob, Johannes; Alsaif, Manar; Andersen, Torgeir Bjørge; Corfu, Fernando**. U-Pb ID-TIMS geochronology of gneisses and metaintrusives in the pre-Caledonian magma-poor hyperextended margin of Baltica. EGU 04-23 -04-28

103. **Jakob, Johannes**; Boulvais, Philippe; Beyssac, Olivier; **Corfu, Fernando**; Alsaif, Manar; **Andersen, Torgeir Bjørge.** Transitional crust in the fossil ocean-continent transition zone of the pre-Caledonian rifted margin of Baltica and its link to the Scandinavian Dyke Complex. The Form Conference: From Orogens to Rifted Margins and back; 06-05 -06-09

104. Jeanniot, Ludovic and **Susanne Buiter**. EGU -3899 (Oral) Analysing the deformation width of transtensional rifted margins. Fri, 28 Apr.

105. **Jerram, Dougal; Henrik Svensen, Sverre Planke**, John Millett, and Pete Reynolds. EGU -18174 (Oral) Sill induced hydrothermal venting: A summary of our current understanding. Fri, 28 Apr.

106. **Jones, M.** Constraining shifts in North Atlantic plate motions during the Palaeocene by U-Pb dating of Svalbard tephra layers. Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

107. **Jones, Morgan T.** Plate Reorganisations and Volcano-Climate interactions during the emplacement of the North Atlantic Igneous Province (62-55 Ma). Invited Talk, Oxford University Earth Science seminar series 25.1.2017.

108. **Jones, M.T. Augland, L.E. Shephard, G.E.** Burgess, S. Eliassen, G.T. **Jerram, D.A**. Jochmann, M. Friis, B. **Planke, S.1 & Svensen, H.H.** Bentonite layers in Svalbard: constraining sources of volcanism, geochronology, and relative plate motions during the Paleogene. NGF Abstracts and Proceedings, no. 1, p. 44.

109. **Jones, Morgan**; Lawrence Percival, Joost Frieling, Tamsin Mather, and **Henrik Svensen**. EGU -10196 (Poster) Assessing the variation in mercury deposition around the North Atlantic during the Palaeocene-Eocene Thermal Maximum (PETM). Tue, 25 Apr.

110. **Kjøll, H.J. Andersen, T.B.** Tegner, C; **Corfu, F.** & **Planke, S.** Wilson-cycle "kick-off": Constraining the influence of a LIP during the Neoproterozoic evolution of the pre-Caledonian margin of Baltica and Laurentia . NGF Abstracts and Proceedings, no. 1, p. 48.

111. **Kjøll, Hans Jørgen; Andersen, Torgeir Bjørge**; Tegner, Christian. Constraining dike emplacement conditions from virtual outcrop modelling. EGU 04-23 to 28

112. Koehl, Jean-Baptiste; Bergh, Steffen G; Henningsen, Tormod & **Faleide, Jan Inge**. Mid/late Devonian-Carboniferous collapse basins along the SW Barents Sea margin. ARCEx Annual Conference; 05-10 to 11.

113. Koehl, Jean-Baptiste; Kvanli, Tor-Einar; Rowan, Mark G. & **Faleide, Jan Inge**. Late Carboniferous salt tectonics in the southwesternmost Nordkapp basin. ARCEx Annual Conference; 05-10 to 11.

114. **Larsen, B.T; Corfu F.** & Heyer, H. U-Pb geochronology of the Oslo Rift. NGF Abstracts and Proceedings, no. 1, p. 52

115. **Larsen, B.T; Gabrielsen, R.H.,** Hjelseth, E.v.d.F., Kleven, M.K.H. Wekenstroo, M. **v.d.Broek, J.** & Vlieg, M. Back-thrusting in the lower Paleozoic Oslo Region foreland-fold-andthrust-belt. NGF Abstracts and Proceedings, no. 1, p.52.

116. Ludovic J. and **Susanne Buiter**, Analysing the deformation width of transtensional rifted margins. EGU April.

117. **Magni, V**. On the importance of along-trench variations on subduction dynamics: from back-arc basins to underplating of continental lithosphere. The formation and deformation of continental margins through Wilson Cycles. 6-9 June 2017, Corsica (Talk).

118. **Magni, Valentina**. Mantle flow and oceanic crust formation during the opening of the Tyrrhenian back-arc basin. EGU(oral) Wed, 26 Apr.

119. Maharjan, D**. Planke, S,** Millett, J.M., **Jerram, D.A** & **Abdelmalak, M.M.** Structure and development of the Vøring Escarpment. NGF Abstracts and Proceedings, no. 1, p.57.

120. Mauri, Guillaume; **Alwi Husein, Karyono Karyono**, Soffian Hadi, Hardi Prasetyo, Matteo Lupi, Anne Obermann, **Adriano Mazzini**, Stephen A. Miller. EGU -12614 (Poster) Insights on the structure and activity of Lusi mud edifice from land gravity monitoring. Fri, 28 Apr.

121. **Mazzini, A. Svensen, H.H.** Forsberg, C.F. Linge,H. Lauritzen, S.-E. Haflidason, H. Hammer, Ø., Planke, S. & Tjelta, T. A Climatic Trigger for the Giant Troll Pockmark Field in the Northern North Sea. NGF Abstracts and Proceedings, no. 1.

122. **Mazzini, Adriano**; Alessandra Sciarra, Matteo Lupi, Guillaume Mauri, **Karyono Karyono, Alwi Husein**, Ida Aquino, Ciro Ricco, Anne Obermann, and Soffian Hadi. EGU -16046 (Poster). Highlight The Lusi mud eruption dynamics: constraints from field data. Fri, 28 Apr.

123. **Medvedev, S.** Self-localizing thermal runaway as a mechanism for intermediate and deep earthquakes: numerical studies and comparison with field observations. Int. Meeting: The formation and deformation of continental margins through Wilson Cycles. 6-9 June 2017, Corsica (Talk).

124. **Medvedev, S.,** Influence of glacial erosion on the topography of Greenland and Scandinavia, In: Joint CEED/BCCR workshop on the Climate of the past 50 million years: "from greenhouse to icehouse". Geilo, Norway, 13-15 February (Talk)

125. **Medvedev, Sergei, Ebbe Hartz, and Jan Inge Faleide.** EGU -8811 (Poster) Vertical displacements of circum-Arctic lithosphere caused by glacial erosion. Mon, 24 Apr.

126. Millett, John; Eric Haskins, Donald Thomas, **Dougal Jerram, Sverre Planke**, Dave Healy, Jochem Kück, Lucas Rossetti, Natalie Farrell, and Simona Pierdominici. EGU -15475 (Oral) Porosity and permeability evolution of vesicular basalt reservoirs with increasing depth: constraints from the Big Island of Hawaii. Tue, 25 Apr.

127. Millett, J.M.; Haskins, Eric; Thomas, Donald; **Jerram, Dougal Alexander; Planke, Sverre;** Healy, D; Kück, Jochem; Rossetti, Lucas; Farrell, Natalie; Pierdominici, Simona. Porosity and permeability evolution of vesicular basalt reservoirs with increasing depth: constraints from the Big Island of Hawai'i.. EGU General Assembly Conference Abstracts; 2017-04-23 - 2017-04-28

128. **Minakov, A.** & **Medvedev, S.** "Analysis of Lithospheric Stresses Using Satellite Gravimetry: Hypotheses and Applications to North Atlantic " has been accepted as a poster presentation during the Fourth Swarm Science Meeting & Geodetic Missions Workshop, 20-24 March , Banff, Canada.

129. **Minakov, A.** & Yarushina, V. Geometry of dyke swarms controlled by brittle failure patterns. NGF Abstracts and Proceedings, no. 1.

130. Haas, P; Jörg Ebbing, **Carmen Gaina**, Defining tectonic boundaries with satellite gravity gradient, DGG Conference, March 2017, Potsdam, Germany (Talk).

131. **Neumann, Else Ragnhild** & Erik Wulff-Pedersen The geology of the Canary Islands. Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

132. Nikishin A.M., Petrov E.I., **Gaina C.,** Malyshev N.A., Freiman S.I., New seismic stratigraphy of the Arctic Ocean and discussions on tectonic history, AAPG/SEG International Conference and Exhibition, October 15-18, 2017, London, UK (Talk).

133. Obermann, Anne; **Karyono Karyono**, Tobias Diehl, Matteo Lupi, **Adriano Mazzini**. EGU - (Oral) Seismicity at Lusi and the adjacent volcanic complex, Java, Indonesia. Fri, 28 Apr.

134. Oliveira, Beñat; **Juan Carlos Afonso**, Sergio Zlotnik, and Romain Tilhac. EGU -18307 (Poster) Numerical Modelling of Multi-Phase Multi-Component Reactive Transport in the Earth's interior. Wed, 26 Apr.

135. Øvrebø, L.K. Thon, K.T. Kunz, A. **Hartz, E.H**.,Husby, Ø. Skillingstad, P. & Johansen, Y.B. Langfjellet: A promising North Sea discovery in a Jurassic structural maze NGF Abstracts and Proceedings, no. 1, p. 88.

136. Panzera, Francesco, Sebastiano D'Amico, Matteo Lupi, **Karyono Karyono** and **Adriano Mazzini.** EGU -17666 | Posters A microtremor survey to define the subsoil structure in a mud volcano areas. Fri, 28 Apr.

137. Peters, Kalijn; Douwe J.J. van Hinsbergen, **Fernando Corfu**, Derya Gurer, Fraukje M. Brouwer, and Herman L.M. van Roermund. EGU -18701 (Poster) Subduction initiation close to the continental margin? Implications from U-Pb zircon geochronology of the Pınarbaşı metamorphic sole, central Turkey. Wed, 26 Apr.

138. Pierdominici, Simona; Jochem Kueck, John Millett, **Sverre Planke, Dougal A. Jerram**, Eric Haskins, and Donald Thomas. EGU -12030 (Poster) Present-day stress state analysis on the Big Island of Hawai´i, USA. Thu, 27 Apr.

139. **Planke, S.,** Millett, J.M., Maharjan, D. Jerram, D.A**., Abdelmalak, M.M.** Groth, A. Hoffmann, J.6, Berndt, C. & Myklebust, R. Igneous seismic geomorphology of buried lava fields and coastal escarpments on the Vøring volcanic rifted margin. NGF Abstracts and Proceedings, no. 1, NGF Abstracts and Proceedings, no. 1, p. 67

140. **Planke, S**; John M Millett, Dwarika Maharjan, **Dougal A Jerram**, Mansour M. Abdelmalak. 3D seismic imaging of voluminous earliest Eocene buried lava fields and coastal escarpments off mid-Norway. EGU General Assembly Conference Abstracts; 2017-04-23 to 28.

141. **Planke, Sverre**; Millett, John; **Jerram, Dougal** Alexander; Senger, Kim; Galland, Olivier; Schmid, Daniel Walter & Myklebust, Reidun. Petroleum exploration in volcanic basins: An overview of the impact of igneous processes and deposits. AAPG GTW “Influence of Volcanism and Associated Magmatic Processes on Petroleum Systems”; 2017-03-14 to 16.

142. **Prieur, N. C**., Wünnemann, K., **Werner, S. C.** : Crater Scaling Results for Rim to Rim Crater Diameter - Influence of Angle of Friction, Cohesion and Porosity on Simple Craters, LPSC, Houston, USA (Oral).

143. **Rolf, Tobias**. Inferences on the uniform sampling of Earth’s latitudes and from self-consistent mantle convection models. 8th Nordic Paleomagnetism Workshop, Iceland 30.9 to 7.10 (Invited talk)

144. Schliffke, Nicholas; Jeroen van Hunen, **Valentina Magni**, Mark Allen, and Rebecca Freeburn. EGU -14029 (Poster) Magmatism in geodynamical models of continental collision zones. Wed, 26 Apr.

145. Schmid, D.W., Iyer, K. Rüpke, L.H. Skeie, J.E. Karlsen, F. & **Hartz, E.H.** Importance of Evolving Fault Seals on Petroleum Systems: Southern Halten Terrace, Norwegian Sea. NGF Abstracts and Proceedings, p. 74.

146. Schmid, D.W., Iyer, K. **Planke, S** & Millett, J. Modeling Hydrothermal Venting in Volcanic Sedimentary Basins: Impact on Hydrocarbon Maturation and Paleoclimate. NGF Abstracts and Proceedings, no. 1, p 73.

147. Schmiedel, T. Kjoberg, S. **Planke, S**. Magee, C. Galland, O. Schofield, N. & Jackson, C.A.-L. Mechanisms of overburden deformation associated with the emplacement of the Tulipan sill, mid - Norwegian margin NGF Abstracts and Proceedings, no. 1, p. 74.

148. Schmiedel, Tobias; **Sigurd Kjoberg, Sverre Planke**, Craig Magee, Nick Schofield, Olivier Galland, Christopher A-L Jackson, and Dougal A Jerram. EGU -1169 (Oral) Mechanisms of overburden deformation associated with the emplacement of the Tulipan sill, mid-Norwegian Margin. Mon, 24 Apr.

149. **Sekhar A**., Asher D. J., **Werner S**. C., Vaubaillon J., Li G., , Change in General Relativistic Precession Rates Due to Lidov-Kozai Oscillations in the Solar System, Lunar and Planetary Science Conference , Houston, TX, USA

150. **Sekhar, Aswin**, David J. Asher, **Stephanie C. Werner**, Jeremie Vaubaillon, and Gongjie Li. EGU -9018 (Poster) Change in General Relativistic precession rates due to Lidov-Kozai oscillations in the Solar System. 26 Apr.

151. **Shephard, G.E**; K.J. Matthews, K. Hosseini, **M. Domeier**. On the consistency of tomographically imaged lower mantle slabs. EGU General Assembly 23-28 April. Vienna, Austria.

152. **Shephard, Grace E**; Mansour M Abdelmalak, **Susanne Buiter**, Karsten Piepjohn, **Morgan Jones, Trond Torsvik, Jan Inge Faleide,** and **Carmen Gaina**. EGU (Poster) Refining plate reconstructions of the North Atlantic and Ellesmerian domains. Mon, 24 Apr.

153. **Shephard. G.E**. On the consistency of tomographically imaged lower mantle slabs. Emerging Leaders Program, Arctic Frontiers . 18-24 January, Bodø-Tromsø, Norway.

154. **Shulgin Alexey** and Hans Thybo. EGU -9568 (Poster) Active seismic profile in east-central Greenland. Seismic explosion sources on an ice cap. Mon, 24 Apr.

155. **Shulgin, Alexey**; Iselin Aarseth, **Jan Inge Faleide**, Rolf Mjelde, and Ritske Huismans. EGU (Poster) The Western Barents Sea: where is the Caledonian Deformation Front? Fri, 28 Apr.

156. **Shulgin, Alexey**; Rolf Mjelde, and **Jan Inge Faleide**. EGU -10085 (Poster) Crustal structure of the South Barents Sea. Mon, 24 Apr.

157. **Sleveland, A. Planke, S**, Zuchuat, V. Franeck, F., **Svensen, H.H**. Midtkandal, I. Hammer, Ø.,Twitchett, R. and the Deltadalen Study Group. Detailed stratigraphic core analyses of the Permian -Triassic transition in Svalbard NGF Abstr. and Proc., no. 1, p. 77.

158. **Sleveland, Arve; Sverre Planke**, Valentin Zuchuat, Franziska Franeck, **Henrik Svensen**, Ivar Midtkandal, Øyvind Hammer, Richard Twitchett, and Deltadalen Study Group. High-resolution stratigraphic analyses of Permian-Triassic core material recovered in central Spitsbergen. 25 Apr.

159. Soelen, Els van; Edi Hasic, **Sverre Planke, Henrik Svensen, Arve Sleveland**, Ivar Midtkandal, Richard Twitchett, and Wolfram Kürschner. EGU -6703 (Poster) Permian-Triassic palynofacies and chemostratigraphy in a core recovered from central Spitsbergen. 25 Apr.

160. **Spakman, W.** Absolute plate motion, slab dragging, and the recent geodynamic evolution of the western Mediterranean region. Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

161. **Stein, H.J.** & **Hannah, J.L.** Dating Oil – Success. NGF Abstr. and Proc. 1, p. 80.

162. **Steinberger, B.** How plume-ridge interaction shapes the distribution of volcanics in the oceans. Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

163. **Steinberger, B., C.P. Conrad**, “Are Superplumes a Myth?”, EGU General Assembly, Vienna, Austria, April .

164. Svendby, Anne Katrine; Osmundsen, Per Terje; Andresen, Arild; **Andersen, Torgeir Bjørge.** Transtensional basins from fault growth to bulk constriction: insights from the `Old Red´ basins of western Norway. EGU 04-23 to 28

165. **Svensen, H.H. Jones, M.T. Augland, L.E. Jerram, D.A., Planke, S., Kjoberg, S.** Iyer, K. Schmid, D.W. & Tegner, C. Linking volcanism and gas release from the North East Atlantic Volcanic Province to the PETM: Challenges and updates. NGF Abstr. and Proceedings, no. 1.

166. **Svensen, Henrik H.; Sverre Planke, Petter Silkoset, Øyvind Hammer**, Karthik Iyer, Dani W. Schmid, and Luc Chevallier. Sills, aureoles and pipes in the Karoo Basin, South Africa, as triggers for Early Jurassic environmental changes. EGU Highlight (Talk).

167. **Tan, Pingchuan**; Sippel, Judith; **Breivik, Asbjørn Johan**; Scheck-Wenderoth, Magdalena & Meessen, Christian. 3D Density Structure of Oceanic Lithosphere Affected by A Plume: A Case Study from the Greater Jan Mayen-East Greenland Region (NE Atlantic). AGU Fall Meeting 12-11 to 16.

168. Tegner, Christian; **Andersen, Torgeir Bjørge**; Brown, Eric L.; **Corfu, Fernando; Planke, Sverre; Kjøll, Hans Jørgen; Torsvik, Trond Helge**. The pre-Caledonian Scandinavian Dyke Complex and 600 Ma plate reconstructions of Baltica. NGF Winter meeting ; 01-09 to 11.

169. Tegner, Christian; **Andersen, Torgeir Bjørge;** Brown, Eric L.; **Corfu, Fernando; Planke, Sverre; Kjøll, Hans Jørgen; Torsvik, Trond Helge.** The pre-Caledonian Scandinavian Dyke Complex and 600 Ma plate reconstructions of Baltica. The FORM conference: From Orogens to Rifted Margins and back; 06-05 to 09.

170. Togia, H.F.R; **C.P. Conrad,** P. Wessel, and G. Ito, "New constraints on tempOral variations in Hawaiian plume buoyancy flux", GSA Cordilleran Section Meeting, Honolulu, HI, May .

171. **Torsvik, T.H.** Earth history from Wegener to ME. Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

172. **Torsvik, T.H.** The Iapetus Ocean and Torgeir Andersen: From the mysterious Opening to the dramatic Closure. From Orogens to Rifted Margins and Back. Int. Meeting: The formation and deformation of continental margins through Wilson Cycles. 6-9 June 2017, Corsica (Talk).

173. **Trond Torsvik** - Phanerozoic palaeogeography and climate. 8th Nordic Paleomagnetism Workshop, Iceland 30.9 to 7.10 (Talk)

174. **Trønnes RG, Eigenmann KR, Mohn CE**. The origin of deep Earth reservoirs with "primordial" He and Ne isotope ratios. Fifth ELSI International Symposium. Tokyo Institute of Technology, Ookayama. Jan. 11-13, Abstr. S4-P17.

175. **Trønnes, Reidar G; Mohn, Chris Erik** & **Eigenmann, K.R**. Origin and structure of Hadean He and Ne isotopic reservoirs in the Earth. Conceiving Earth Evolution and Dynamics, San Cristobal de La Laguna, Tenerife, Prog. Abstr. 43-44.

176. Trulsvik, M. **Zastroznov, D**, Polteau, S. **Planke, S**. & Myklebust, R. The structure and hydrocarbon potential of the conjugate NE Greenland and Vøring margins. NGF Abstracts and Proceedings, no. 1, p. 85.

177. **Viennet, Jean Christophe, Bultel, Benjamin,** Riu, Lucie, **Wernet, Stephanie,** Investigation of eraly Mars envionments by performing experiments devoted to mineralogical competitions. International clay conference (July , Granda, Spain).

178. **Werner, S.** What shapes a planet – Extra-terrestrial examples. Conceiving Earth Evolution and Dynamics. 17 to 19 October, ULL, San Cristóbal de La Laguna, Tenerife North (Talk).

179. Wessel, P; and **C.P. Conrad**, “Assessing Pacific absolute plate and plume motions”, GSA Cordilleran Section Meeting, Honolulu, HI, May (Talk).

180. Yenwongfai, Honore Dzekamelive; Mondol, Nazmul H; **Faleide, Jan Inge** & Lecomte, Isabelle. Petrofacies characterization using prestack inversion and neural networks within the Snadd Formation of the Goliat Field, SW Barents Sea. Vinterkonferansen; 2017-01-09 to 11.

181. Yenwongfai, Honore Dzekamelive; Mondol, Nazmul Haque; Lecomte, Isabelle; **Faleide, Jan I**. Quantitative Seismic interpretation strategies for petrofacies discrimination within the Triassic: A Goliat Case Study. Talking Trias 2017-10-25 to 26. (Talk)

182. Yenwongfai, Honore Dzekamelive; Mondol, Nazmul Haque; Lecomte, Isabelle; **Faleide, Jan Inge;** Leutscher, J. Integrating prestack inversion, machine learning, and forward seismic modelling for petrofacies characterization: A Barents Sea case study. 4th International Workshop on Rock Physics; 05-29 to 06-02 (Talk).

183. Zertani, Sascha; Timm John, Frederik Tilmann, Hem Bahadur Motra, Loic Labrousse, and **Torgeir B. Andersen**. EGU -18686. Petrophysical properties of eclogite facies (Poster).

Staff, students and visitors

Professors, Associate Professors and Researchers 19,6 **Man-years**

Name	Funded by	from	to	working months	% of full position	nationality
Andersen, Torgeir B.	UiO-IG	01.03.13	28.02.18	9	75	Norway
Corfu, Fernando	UiO-IG	01.03.13	28.02.18	2,4	20	Switzerland
Dypvik, Henning	UiO-IG	01.03.13	28.02.18	3,6	35	Norway
Faleide, Jan Inge	UiO-IG	01.03.13	28.02.18	3,6	35	Norway
Gabrielsen, Roy H.	UiO-IG	01.03.13	28.02.18	3,6	35	Norway
Kürschner, Wolfram	UiO-IG	01.03.13	28.02.18	3,6	35	Germany
Maupin, Valerie	UiO-IG	01.06.16	28.02.18	6		France
Neumann, Else Ragnhild	Professor Emerita					Norway
Stordal, Frode	UiO-IG	01.03.13	28.02.18	2,4	20	Norway
Trønnes, Reidar	UiO-NHM	01.03.13	28.02.18	9	75	Norway
Torsvik, Trond H	UiO-IG	01.03.13	28.02.18	12	100	Norway
Breivik, Asbjørn	UiO-IG	15.10.14	28.02.18	6		Norway
Werner, Stephanie	UiO-IG	01.03.16	28.02.20	9	50	Germany
Schweitzer, Johannes	Norsar, in kind	01.09.15	31.08.19	2,4	20	Germany
Afonso, Juan Carlos	143906	01.10.16	30.05.18	2,4	20	Australia
Buiter, Susanne	143906	01.05.16	28.02.18	2,4	20	The Netherlands
Bull Aller, Abigail	143906	01.05.16	07.02.17	1	100	UK
Bull Aller, Abigail		05.11.17	16.05.18		maternity leave	
Conrad, Clinton P.	143906	01.08.16	30.07.19	12	100	US
Domeier, Mat	144312	07.08.16	06.02.19	12	100	US
Dubrovine, Pavel	143997	01.10.16	31.12.18	3	25	Russia
Dubrovine, Pavel	143996	01.10.16	28.02.18	9	75	
Gaina, Carmen	143906	01.03.13	28.02.18	12	100	Romania/Australi
Hannah, Judith	421048	01.07.12	30.06.18	6	50	USA
Hartz, Ebbe H.	143906	01.03.13	15.10.17	2,4	20	Denmark
Jahren, A. Hope	143906	01.09.16	31.08.19	12	100	US
Jerram, Dougal	143906	01.03.13	28.02.18	2,4	20	UK
Jones, Morgan	144450	18.09.17	02.12.20	3	100	UK
Mazzini, Adriano	0, 152290	01.03.13	31.12.18	2	20	Italy
Mazzini, Adriano	650129	01.03.13	31.12.18	10	80	
Medvedev, Sergei	690471	01.12.16	31.01.17	1	100	Russia
Medvedev, Sergei	430369	01.02.17	14.11.17	10		
Medvedev, Sergei	143906	15.11.17	15.01.18	0,2	20	
Minakov, Alexander	690471	01.10.16	30.09.17	12	100	Russia
Mohn Chris E.	143906	01.06.13	28.02.18	12	100	Norway
Niscancioglu, Kerim H.	144151	01.08.15	31.07.20	2,4	20	Norway
Planke, Sverre	143906	01.03.13	28.02.18	2,4	20	Norway
Polozov, Alexander	143906	01.03.13	28.02.18	2,4	20	Russia
Spakman, Wim	143906	01.03.13	28.02.18	2,4	20	The Netherlands
Stein, Holly	421048	01.07.12	30.06.18	6	50	USA
Steinberger, Bernhard	143906	01.05.16	28.02.18	2,4	20	Germany
Svensen, Henrik	143906	01.05.16	28.02.18	12	100	Norway
Watson, Robin	143906		31.12.17	6,0	At NGU	

Professors, Associate Professors and Researchers 19,6 Man-years

Name	Funded by	from	to	working months	% of full position	nationality
Andersen, Torgeir B.	UiO-IG	01.03.13	28.02.18	9	75	Norway
Corfu, Fernando	UiO-IG	01.03.13	28.02.18	2,4	20	Switzerland
Dypvik, Henning	UiO-IG	01.03.13	28.02.18	3,6	35	Norway
Faleide, Jan Inge	UiO-IG	01.03.13	28.02.18	3,6	35	Norway
Gabrielsen, Roy H.	UiO-IG	01.03.13	28.02.18	3,6	35	Norway
Kürschner, Wolfram	UiO-IG	01.03.13	28.02.18	3,6	35	Germany
Maupin, Valerie	UiO-IG	01.06.16	28.02.18	6		France
Neumann, Else Ragnhild	Professor Emerita					Norway
Stordal, Frode	UiO-IG	01.03.13	28.02.18	2,4	20	Norway
Trønnes, Reidar	UiO-NHM	01.03.13	28.02.18	9	75	Norway
Torsvik, Trond H	UiO-IG	01.03.13	28.02.18	12	100	Norway
Breivik, Asbjørn	UiO-IG	15.10.14	28.02.18	6		Norway
Werner, Stephanie	UiO-IG	01.03.16	28.02.20	9	50	Germany
Schweitzer, Johannes	Norsar, in kind	01.09.15	31.08.19	2,4	20	Germany
Afonso, Juan Carlos	143906	01.10.16	30.05.18	2,4	20	Australia
Buiter, Susanne	143906	01.05.16	28.02.18	2,4	20	The Netherlands
Bull Aller, Abigail	143906	01.05.16	07.02.17	1	100	UK
Bull Aller, Abigail		05.11.17	16.05.18		maternity leave	
Conrad, Clinton P.	143906	01.08.16	30.07.19	12	100	US
Domeier, Mat	144312	07.08.16	06.02.19	12	100	US
Dubrovine, Pavel	143997	01.10.16	31.12.18	3	25	Russia
Dubrovine, Pavel	143996	01.10.16	28.02.18	9	75	
Gaina, Carmen	143906	01.03.13	28.02.18	12	100	Romania/Australi
Hannah, Judith	421048	01.07.12	30.06.18	6	50	USA
Hartz, Ebbe H.	143906	01.03.13	15.10.17	2,4	20	Denmark
Jahren, A. Hope	143906	01.09.16	31.08.19	12	100	US
Jerram, Dougal	143906	01.03.13	28.02.18	2,4	20	UK
Jones, Morgan	144450	18.09.17	02.12.20	3	100	UK
Mazzini, Adriano	0, 152290	01.03.13	31.12.18	2	20	Italy
Mazzini, Adriano	650129	01.03.13	31.12.18	10	80	
Medvedev, Sergei	690471	01.12.16	31.01.17	1	100	Russia
Medvedev, Sergei	430369	01.02.17	14.11.17	10		
Medvedev, Sergei	143906	15.11.17	15.01.18	0,2	20	
Minakov, Alexander	690471	01.10.16	30.09.17	12	100	Russia
Mohn Chris E.	143906	01.06.13	28.02.18	12	100	Norway
Niscancioglu, Kerim H.	144151	01.08.15	31.07.20	2,4	20	Norway
Planke, Sverre	143906	01.03.13	28.02.18	2,4	20	Norway
Polozov, Alexander	143906	01.03.13	28.02.18	2,4	20	Russia
Spakman, Wim	143906	01.03.13	28.02.18	2,4	20	The Netherlands
Stein, Holly	421048	01.07.12	30.06.18	6	50	USA
Steinberger, Bernhard	143906	01.05.16	28.02.18	2,4	20	Germany
Svensen, Henrik	143906	01.05.16	28.02.18	12	100	Norway
Watson, Robin	143906		31.12.17	6,0	At NGU	

PhD candidates 12,9 Man-years

Name	Funded by	from	to	working months	% of full position	nationality
Baron, Marzena A.	UiO-IG-KD F142	01.09.13	31.08.16	8	100	Poland
Bostic, Joshua	UiO-IG-KD F143	04.09.17	03.09.20	4	100	US
Heimdal, Thea H.	UiO-IG-KD F143	03.08.15	02.08.17	7	100	Norway
Heimdal, Thea H.	143906	03.08.17	02.08.18	5	100	
Heyn, Björn H.	UiO-IG-KD F 144	15.09.16	14.09.19	12	100	Germany
Husein, Alwi	650129	01.05.15	30.07.18	12	20	Indonesia

Technical-administrative staff 4,0 Man-years

Name	Funded by	from	to	working months	% of full position	nationality
Birkelund, Anniken R.	144251	07.03.16	permanent	5	100	Norway
Birkelund, Anniken R.			30.05.18		maternity leave	
Gørbitz, Trine-Lise	143906	01.03.13.	permanent	12	100	Norway
Haugland, Vanja	144251	14.08.17	20.06.18	5	100	Norway
Silkoset, Petter	152200	01.01.16	permanent	2	100	Norway
Sørlie, Anita	152240	15.06.16	permanent	12	100	Norway
Hagopian, William	143906-120000	01.01.17	31.12.19	12	100	US

Short term or hour-based salary

Name	Funded by	from	to	working months	% of full position	nationality
Ballo, Erik	143906-913802					Norway
Benites, Tulio	143906-913801					
Busengdal, Marte	143906-913918					Norway
Guren, Marthe G.	143906-913807	01.08.17	31.12.17			Norway
Mironova, Anna	143906-913808	01.11.17	28.02.18	2	100	Russia
Personen, Lauri	144251	03.04.17	08.04.17			Finland
Uehara, Dan	143906-913918	01.12.17	31.01.18			Australia

Guest researchers 0,8 Man-years

Name	Title	from	to
Aarset, Iselin	PhD-student for Breivik in Bergen		
Abdelmalak, M. Mansour	Guest researcher	17.05.17	31.07.17
Aleksey Smirnov	Associate Professor, Michigan Technological U	01.07.17	10.07.17
Bebin, Alysse	Master student	17.04.17	16.06.17
Benjamin Lysak	Master student, University of Alberta	01.05.17	28.05.17
Bostoic, Joshua		two periods	
Brau, Joanna	Master, Grenoble France		
Closset, Pierre	Student, Strasbourg	12.07.17	29.07.17
Freiman, Sergey	PhD student, University of Moscow	28.08.17	08.09.17
Halvorsen, Erik	PhD student		
Hlavatskyi Dmytro	PhD stud., National Academy of Sciences of Uk	29.05.17	09.06.17
Hoffmann, Volker	Guest researcher	07.03.16	28.02.17
Janin, Alexandre	Masters internship from Ecole Normale Supérie	16.04.17	18.06.17
Jegheh, Farshad Sala	Guest	23.09.17	03.10.17
Kristensen, Mathis Gaarde	Erasmus Exchange student		
Kseniia Bondar	Researcher, Taras Shevchenko National Univers	06.03.17	17.03.17
Montesi, Laurent	Professor		01.08.17
NN i Paloogmag Lab			
Schliffke, Nico	PhD student, Durham and SUBITOP		
Schubert, Brian		12.06.17	16/17.6
Tema Evdokia	Research assistant, University of Torino	12.06.17	23.06.17
Valeriani, Lucrezia	Guest student, Padova		
Wang, Kaiming	PhD guest student	16.09.17	15.09.18
Åkesson, Henning	PhD-student, Bergen		monthly

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