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Summary: <p>Young Trondhjemites, the conference for young researchers working with geosciences and engineering in Trondheim, has been arranged in 2018 for the third time. The conference has been held at the Geological Survey of Norway (NGU) on the 16 of March. The programme included 3 invited talks. The first of these talks was presented by Jørn H. Hurum, who gave tips on outreach. The two other invited talks were related to petroleum geology and were respectively given by André Jensen, who presented the Norwegian Petroleum Directorate, and by Tor-Ole Jøssund, who introduced the audience to oil production. The young researcher community contributed with 9 oral presentations and 10 posters. The abstracts of these contributions are presented in the programme order. Finally, 4 workshops have been organised to offer the opportunity to the participants to discuss and learn about how to write an article, how to hold a presentation, how to prepare a poster or how to use a camera to obtain a point cloud (photogrammetry). Around 55 young researchers participated in the conference. The conference has been organised thanks to the support of Norsk Bergforening, the Department of Geoscience and Petroleum (NTNU), AkerBP, Norsk Bergindustri, Forskerforbundet and the Geological Survey of Norway (NGU).</p>					
Keywords:		Geosciences		Trondheim	

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Programme

Schedule

09:00 – 09:30 Registration & coffee

09:30 – 09:42 Lake sediment analyses from Nedre Glomsjø flood event, southeastern Norway – *Helle Daling Nannestad, Ivar Berthling, Fredrik Høgaas*

09:42 – 09:54 Reconstruction of the deglaciation history in the Gråsteindalen area, Geiranger – *Line Nygård*

09:54 – 10:06 Characterization of geomorphological and topographical features on complex colluvium fan – *Gro Sandøy, Lena Rubensdotter, Pierrick Nicolet*

10:06 – 10:18 The impact of submarine mine tailings disposal on the fjord bottom in Frænfjorden, Norway – *Nicole J. Baeten, Reidulv Bøe, Aivo Lepland, Oddvar Longva, Shyam Chand, Arnstein Amundsen*

10:18 – 10:30 High resolution CFD modelling of erosion process – *Nadeem Ahmad*

10:30 – 10:42 Møre Pilot, Available research funds & high-resolution DEM and bathymetry data of Søre Sunnmøre – *Espen Bergø*

10:45 – 11:00 Powertalks (following poster programme order)

11:00 – 11:30 Break & poster session + fruits and coffee

11:30 – 12:30 Guest talk: *Jørn H. Hurum* on "Outreach – Marine monster and apes"

12:30 – 13:00 Lunch

13:00 – 13:10 Guest talk: *André Jensen* presents the Norwegian Petroleum Directorate

13:10 – 13:40 Guest talk: *Tor-Ole Jøssund* (AkerBP): From Plan for Installation and Operation to production

13:40 – 13:52 Sub-ice topography of Nordaustlandet, Svalbard, derived from potential field modeling – *Marie-Andrée Dumais, Marco Brönnner*

13:52 – 14:04 Methodology of RMR modification for slope stability – *Mario Morales*

14:04 – 14:16 Can we use animation as a research tool? – *Tine Larsen Angvik*

14:30 – 15:00 Break & poster session + coffee and fruit

15:00 – 16:00 Workshop 1

16:00 – 17:00 Workshop 2

17:00 – 17:30 Poster session w/ refreshments

17:30 Dinner, awards and quiz

Poster programme

Patterns of erosion during recent glaciations in South Greenland – *Jane L. Andersen, David L. Egholm, Mads F. Knudsen, Jesper Olsen*

Laboratory facilities at NGU – *Ana Banica*

Marine and terrestrial data in Herøy kommune – *Espen Bergø*

Mapping the fjords – *Sigrid Elvenes & Jochen Knies*

Automated classification of coral deposits in Romsdalsfjorden – *Alexandra Jarna, Sigrid Elvenes, Reidulv Bøe*

Landslide hazard assessment in NE India along the Gangtok-Tsomgo/Changu Lake and Gangtok-Chungthang-Yumthang corridors – *Reginald Hermanns, John Dehls, Ivanna M. Penna, Odd André Morken, Rajinder Bhasin, Sengupta Aniruddha and Vikram Gupta*

Fossilisation by Mg-calcite: mineralized microbes(?) in methane-derived carbonates from the Vestnesa Ridge, off western Svalbard – *Tobias Himmler, Richard Wirth, Tõnu Martma, Gerhard Bohrmann, Stefan Bünz, Jochen Knies, Aivo Lepland*

Tafoni and weathering pit growth rate and controlling environmental factors in maritime climate, Vågsøy, western Norway – *Annina Margreth, Ola Fredin, Henriette Linge, Bradley W. Goodfellow, Valentin Burki, Lena Rubensdotter*

Not all carbon-footprint calculators are created equal – Ducky Eco's solution – *Amy McCormack*

Selected threats to the quality of groundwater in Northern Poland and ways to deal with them – *Sabina Zaba*

Programme committee

Paula Hilger (NGU)

Frank Jakobsen (NGU)

Alexandra Jarna (NGU)

Pierrick Nicolet (NGU)

Ben Snook (NTNU)

Sponsors

The conference has been organised thanks to the support of:



Oral presentations

LAKE SEDIMENT ANALYSES FROM NEDRE GLOMSJØ FLOOD EVENT, SOUTHEASTERN NORWAY

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Sediment cores from lakes and mires can provide geological archives of paleofloods. By analysing the sediments we can better our understanding of the nature and impact of large flood events. This study aims to constrain the run-up height and timing of the outburst flood from glacial lake Nedre Glomsjø at the end of the last Ice Age. Cores from three lake basin have been examined for grain size distribution, total organic carbon (TOC) and macrofossil content. In addition, we aim to provide a geochemical profile (using XRF) of the flood layer and properly constrain the event in time by radiocarbon dating macrofossils found above and under the flood sediment. Geochemical data will serve as a geomarker in order to identify the flood layer elsewhere. The flood layer stands out as a light, fine-grained layer in all of the retrieved cores. The upper boundary towards the organic gyttja is sharp, which signals that the sedimentation stopped abruptly. Preliminary results indicate that the flood inundated basins more than 50 m above the valley floor in our study area.

RECONSTRUCTION OF THE DEGLACIATION HISTORY IN THE GRÅSTEINDALEN AREA, GEIRANGER

Line Nygård

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The North-Western part of Norway became ice free during the Late Weichselian glaciation and the ice margin is mapped across several fjord districts. Distinct moraine systems in the high mountains in inner Sunnmøre indicate an extensive local glaciation during the Younger Dryas, resulting in cirque formation. Exposure ages of rock surface samples west of Gråsteindalen valley indicate that the deglaciation of the main and side valley started before 17,7 ka in the Late Weichselian. At the southern end of Gråsteindalen valley a prominent lateral moraine has been studied by others and it has been claimed to be of Younger Dryas age. An additional exposure age of $11,3 \pm 1,48$ ka indicates that the lateral moraine was deposited by the ice sheet during the advance in Younger Dryas. Terminal moraines in Gråsteindalen valley and the side valley are believed to be of the same age as the lateral moraine south of Gråsteindalen valley, and indicate that the high mountains had local glaciers, leaving an ice-free area between the local glaciers and the ice sheet in the study area. The result from the Quaternary geological and geomorphological mapping in the study area reveals terminal moraines from several glacier advances, where some of them are believed to be of Younger Dryas age (12,8-11,7 ka) and another advance associated with the Erdalen Event (10,1-9,7 ka). The most recent glacier advances are thought to have happened during the Little Ice Age (ca. 1300-1920), when the glaciers existed as isolated

cirque glaciers. The four cirques in the study area have different aspects, facing towards NE, N and SW, and reflect different cirque development and glacier distribution.

CHARACTERIZATION OF GEOMORPHOLOGICAL AND TOPOGRAPHICAL FEATURES ON COMPLEX COLLUVIUM FAN

Gro Sandøy, Lena Rubensdotter, Pierrick Nicolet

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The Geological Survey of Norway (NGU) has since 2014 produced high resolution (1: 10 000) Quaternary geological maps with special emphasis on rapid slope processes; rockfall, snow avalanches and debris flows. The maps are produced in areas where state funded (NVE) hazard-mapping is made by private consultants, and only if the geology is complex. Previous experiences from slope hazard evaluations reveal some uncertainties about the precise interpretation of complex avalanche fans, especially fans influenced by slush avalanches and debris flows.

To increase the general understanding of these complex avalanche fans and their surface morphology, a minor research project was initiated in 2016. The project focuses on characterizing geomorphological and topographical features on 3 complex fan systems located in Sunndalen (Snøva and Ottem) and Drivdalen (Stølåkollen), mid Norway. Since September 2016 the sites have been monitored by permanent cameras, which are programmed to acquire 6 photos per day. Detailed surface morphology (DEM) is being acquired through structure-from-motion using drone pictures and through terrestrial laser scanning.

Since the project started, in 2016, the camera has registered around 200 snow avalanches, where Snøva is the most active site with 162 avalanches. The results will be combined with detailed field work and used as a reference to interpret the present surface morphology of other fans. A master project at Bergen University will be connected to this project from summer 2018, where the goal is to carry out mapping of the fans surface and investigate the stratigraphy.

THE IMPACT OF SUBMARINE MINE TAILINGS DISPOSAL ON THE FJORD BOTTOM IN FRÆNFJORDEN, NORWAY

Nicole J. Baeten¹, Reidulv Bøe¹, Aivo Lepland¹, Oddvar Longva¹, Shyam Chand¹, Arnstein Amundsen²

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Omya Hustadmarmor mines marble in the region around Frænfjorden. The rest products (calcium carbonate tailings) have been discharged into the fjord since 1982. The discharge takes place through pipes at a flexible distance from the shore, at water depths between 20-40 meter. As part of the NYKOS project (New knowledge on Sea Disposal), NGU collected multibeam echosounder data, shallow seismic, videos, grabs and sediment cores in Frænfjorden in 2015 and 2016. This data has been used to create a sediment grain size map, and study the distribution, deposition and impact of the mine tailings on the fjord bottom.

HIGH RESOLUTION CFD MODELLING OF EROSION PROCESS

Nadeem Ahmad

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Presently, there is no model to simulate scouring/erosion under the different wave climate together with sharp capturing of the free surface and bed level change. The problem become further complicated when the flow on the coastline is obstructed by the coastal structure or the stability of the coastline itself is vulnerable to the climate change.

Therefore, our research focuses the vulnerability of the coasts due to the climate change and is important for the precise capturing and the analysis of waves with the coastal erosion such as: the arctic coastal erosion, pipelines erosion under the combined action of the wave plus current, scour around the large diameter cylinder and the jacket structures and the seawall erosion. The modelling of the erosion process is based on three-dimensional (3D) Navier-Stokes equations coupled with the 3D morphological model by incorporating the sediment properties such as median sediment size, sediment density, sediment porosity and the shields parameter. This feature makes model more robust and efficient to simulate the erosion process for different morphologies.

MØRE PILOT, AVAILABLE RESEARCH FUNDS & HIGH-RESOLUTION DEM AND BATHYMETRY DATA OF SØRE SUNNMØRE

Espen Bergø

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“Marine Grunnkart” is a part of a project to gather the first publically available high-resolution seafloor maps in Norway. The results from this project is elegantly summed the phrase:

“before we thought, now we know”

(“før trodde vi, nå vet vi”)

Previously we had limited knowledge of the seafloor in our coastal areas, where decision making, area management and zoning were based on guesswork. Whereas now we have high-resolution bathymetry covering most of these areas eliminating the guesswork, and allowing for new insights and knowledge. The new data and knowledge provide a much better foundation for making educated decisions, reduce costs and increase efficiency in local and central government tasks, undertake new research, promote local businesses, including outdoor recreation and kelp farming.

In addition to high-resolution bathymetric data, Søre Sunnmøre also has a research project aiming to map the shallow-marine areas near the shoreline that are not covered by the bathymetric or terrestrial data acquisition. This project is now finished, resulting in a single 1x1m resolution 3D model of Søre Sunnmøre, from the tallest peak, to the beaches and all the way to the seafloor.

However, proper data need proper usage. Therefore, Herøy kommune will support further research into our coastal areas in Søre Sunnmøre. We would like to fund research in this area; especially bachelor and master theses that give us new insights and knowledge about our coastal areas.

We are looking for applicants who want to do a research project or write a thesis using our marine and terrestrial 3D elevation data.

Contact Herøy kommune to see if your project is applicable for funding. If your project is not applicable for funding, the 3D dataset is still available for use in research free of charge.

SUB-ICE TOPOGRAPHY OF NORDAUSTLANDET, SVALBARD DERIVED FROM POTENTIAL FIELD MODELING

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Potential field methods such as gravity and magnetic interpretation provide valuable information to quantify the subsurface and are especially useful where geological exposures are sparse or in remote and difficult terrains.

With the ongoing climate change the ice caps in the polar regions are often referred to as a principal visual expression for the warming of the Earth's atmosphere, which is why a comprehensive monitoring of the polar ice regions and ice thickness changes are of particular interest. Satellite missions are common methods to estimate ice sheet elevation change but fail to provide direct ice thickness measurements. Ground measurements with ice penetrating radar (IPR) can supply ice thickness but are arduous and time-consuming for large areas. Furthermore, ice thickness estimation from IPR is temperature-dependent, which can cause uncertainties. Using airborne gravity measurements, combined with accurate and reliable altimetry data, due to a significant density contrast between ice and bedrock sub-ice topography and ice thickness can be effectively derived. Airborne gravity data have the advantage to be acquired efficiently over large areas in a short time frame.

Nordaustlandet, the second largest island on Svalbard archipelago and covered up to 80% by ice, has been investigated by the available aero-gravity and -magnetic data to retrieve the sub-ice topography and the geophysical properties of the subsurface. Aero-gravity survey, SAG-99 was acquired above North East Greenland coast and Svalbard, including Nordaustlandet by KMS (Kort & Matrikelstyrelsen) and UiB (Universitet i Bergen).

For the forward modelling, initial average densities of 2.67 g/cm³ and 0.91 g/cm³ for the bedrock and ice, respectively were input, and topographic measurements were used for constraints. The synthetic modelled signal output was compared to the free-air anomaly. Therefore, the ice thickness model relied primarily on the gravity data. Furthermore, the magnetic signature is an indicator of the presence of crystalline rocks and provides an extra insight of the basement distribution. This contributes to refine the range of density expected under the ice and allow the improvement of the sub-ice model. Therefore, the magnetic and gravity interpretation also yielded to a better understanding of the geology and offered a better control of the physical properties of the bedrock underneath Austfonna, Nordaustlandet.

From the model, the ice thickness and the bedrock topography were extracted. For accuracy and resolution assessment, our results were compared to independent bed elevation map previously produced by radio echo sounding data acquired on Austfonna.

METHODOLOGY OF RMR MODIFICATION FOR SLOPE STABILITY

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In hard rock environments, the most employed starting point for evaluating slope stability conditions is the characterization of the rock mass. Considering that slope stability might be influenced by parameters that are underrepresented in the original formulation of RMR, such as jointing characteristics and groundwater behavior, then the stability assessment of a given slope, using these original RMR values, might also carry inaccuracies. The objective is to develop a methodology to consequently modify the correspondent RMR ratings, and that might be applied at any given slope. The adjustment is accomplished by calculating weights, or degrees of importance, for each parameter encompassed into RMR. These weights are resultant from the process of pairwise comparison comprehended into the Analytical Hierarchy Process (AHP). AHP decompose a problem into a hierarchy of simpler sub-

problems, each of which can be independently analyzed. Calculation guidelines are provided for adjusting RMR given the new weights. The main outcome is that the method provides an enhanced rock mass rating for assessment of slope stability.

CAN WE USE ANIMATION AS A RESEARCH TOOL?

Tine Larsen Angvik

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3D animation is not what you would normally associate with science and is more likely to be connected to Disney or similar. To be able to use animation for science we need to understand the different aspects of animation such as how to animate in 3D, the use of real data and interpretations, and the possibilities of data processing with animation programs. We present a new project at NGU which will be built in three steps: first we will build the animation skills for visualizing geological features, then we will take data or interpretations from a real location and animate them backward and forward in time to visualize the progressive development for the study area. Lastly, we would like to find out if we can use the animation program with plug-ins to be able to run calculated 3D simulations through time. The program used for animation is Blender, an open source program, that has many similarities with a geological 3D interpretation program. There are further possibilities for Python script plug-ins for simple data simulation. The products developed from the project will be used for teaching, making geology films, visualization of research data in conference presentations and in 3D research articles. The project will bring visualization of research to a new level that will make 3D data more understandable both for the public and for scientists.

Posters

PATTERNS OF EROSION DURING RECENT GLACIATIONS IN SOUTH GREENLAND

Jane L. Andersen, David L. Egholm, Mads F. Knudsen, Jesper Olsen

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Ice-sheet dynamics are determined not only by climate, but also by the morphology of the landscapes beneath the ice. Because ice sheets pluck and abrade rock as they slide over their beds, they continuously remould their own substratum. In turn, this changes the dynamics of the ice, for example by transforming v-shaped fluvial valleys into u-shaped valleys that are better optimized for ice discharge.

Along the previously glaciated passive continental margins that fringe the North Atlantic, recent ice sheets most likely advanced across landscapes that were deeply dissected by earlier ice sheets. The timing and rates of landscape evolution are, however, poorly constrained.

In this study, we set out to constrain erosion patterns during the most recent glacial periods beneath the South Greenland Ice Sheet using fifty new in-situ cosmogenic ^{10}Be and ^{26}Al pairs in bedrock and boulder erratics. Cosmogenic nuclides are produced in minerals near Earth's exposed surface by interaction with cosmic radiation. High nuclide concentrations in bedrock indicate slow erosion. Our results demonstrate a clear gradient in erosion with the highest rates found at lowest elevation. Furthermore, steering of ice into troughs led to substantial erosion, even at elevations above 1500 m a.s.l., while bedrock on summit sites at similar elevations were eroding much slower. These results constrain the landscape evolution at the South Greenland ice-sheet margin during recent glacial periods.

LABORATORY FACILITIES AT NGU

Ana Banica

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NGU's Laboratory (NGU-Lab) has a wide range of analytical instruments and equipment suited for analyses and testing of geological materials, like geochemical analysis, mineral identification and quantification, geochronology, particle size analysis, X-ray imaging and core logging, petrophysics and paleomagnetism, mechanical testing of raw materials for buildings, concrete, roads and infrastructure. There are also facilities for preparation of thin section and for mineral separation.

Through their laboratory services for analysis of geological materials and water, NGU-Lab supports NGU's main activities in the fields of research, prospecting and management. NGU-Lab delivers "fit-for-purpose" analytical methods and develops new methods in collaboration with other research groups within NGU, research institutes and universities. Several methods are accredited, and our quality system complies with the requirements of the ISO/IEC 17025 standard. Students involved in research and development projects at NGU are getting good opportunities to learn new methods and procedures for sample preparation and analysis.

MARINE AND TERRESTRIAL DATA IN HERØY KOMMUNE

Espen Bergø

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Marine and terrestrial data in Herøy kommune

- New possibilities in onshore – offshore geological investigations

The pilot projects, Marine grunnkart (NGU 2016) and Green laser in Søre Sunnmøre have resulted in multiple high-quality elevation and bathymetric datasets allowing new insights into onshore-offshore geology due to the detailed resolution of the datasets.

The data consists of three different datasets:

- National height data, covers all of Norway, with a 1x1m resolution in Herøy kommune.
- Green laser data, Covers the shallow marine areas of Herøy kommune (pilot project).
- Marine grunnkart, bathymetric data covering most of the marine areas in Herøy kommune.

By combining these datasets, one can create a single elevation model of an area of interest, allowing for detailed onshore-offshore studies. To highlight the possibilities and showcase the data, brittle faults have been interpreted in select areas in Herøy kommune. The preliminary interpretation shows that brittle faults can be easily identified onshore, offshore and in shallow marine strandflats in the areas.

MAPPING THE FJORDS

Sigrid Elvenes & Jochen Knies

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The spectacular landscape of North Norway is no less spectacular below sea level. Alpine peaks in the Ofoten region are surrounding steep-sided fjords as deep as 700 m, strong tidal currents brimming with marine life, and glacial deposits both large and small offering insight into the processes that shaped this area. Even today sizeable volumes of sediment are transported into the marine environment, ending up on the seafloor.

A population of 25 000 makes use of the marine areas of the Ofoten region, e.g. for transportation, shipping, fisheries, aquaculture, and recreation. Human activities may however affect the ecological status of these water bodies, and many potential sources of pollution exist. Mining and other industries, the iron ore traffic through Narvik, and waste and runoff from population centres and agriculture are among these.

Through a 2-year mapping programme, NGU aims to produce high-resolution, thematic, marine base maps of the municipalities Ballangen, Evenes, Narvik, Tjeldsund and Tysfjord. Based on detailed multibeam echosounder data, samples, and observations, these are full-coverage maps of seabed sediment distribution and the technical properties of the various seabed types – valuable information for future spatial planning of the marine areas. To better understand sedimentary processes in the area, and to map the regional distribution of heavy minerals and organic pollutants, we have also conducted geochemical analyses of cores and surface samples of major sedimentary basins in the Ofoten and Tysfjorden fjords, where soft sediment has accumulated over millennia.

AUTOMATED CLASSIFICATION OF CORAL DEPOSITS IN ROMSDALSFJORDEN

Alexandra Jarna, Sigrid Elvenes, Reidulv Bøe

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Over many years, NGU has been mapping bioclastic sediments and coral reefs along the Norwegian coast and in the offshore areas. Until recently, all maps have been digitized manually in ArcGIS, based on geologists' expert interpretation of available acoustic data from multibeam echosounders (MBES) and ground truthing by video observation and sediment samples. This approach is time-consuming and may be subjective. To this end, we are developing and testing methods for automated mapping based on MBES data, using Object-Based Image classification Analysis (OBIA) in eCognition and ArcGIS. Our goal is to develop a more efficient and objective mapping approach.

The main products from the project in Romsdalsfjorden (Norway) are a polygon data set that shows areas with bioclastic sediments (skeletal or shell residues from dead organisms) and a point data set that shows probable and possible coral reefs. Bioclastic sediments can be associated with living corals, so they indicate areas where we should put extra care. In the study area, we have combined 432 point objects in two classes: probable and possible coral reefs. The probable class consists of 332 manually defined points based on results of automatic OBIA classification in eCognition, while the possible class contains 100 manually defined points from steep mountain sides, also based on automatic OBIA classification in eCognition.

In the future it could be beneficial to move away from the all-manual mapping methodology and go towards more automated methods. We test and compare some automated or semi-automated mapping approaches to assess their potential benefits for future mapping, considering both map production efficiency and the quality of the product.

LANDSLIDE HAZARD ASSESSMENT IN NE INDIA ALONG THE GANGTOK-TSOMGO/CHANGU LAKE AND GANGTOK-CHUNGTHANG-YUMTHANG CORRIDORS

Reginald Hermanns¹, John Dehls¹, Ivanna M. Penna¹, Odd André Morken¹, Rajinder Bhasin², Sengupta Aniruddha³ and Vikram Gupta⁴

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In seismically active high mountain settings such as the Himalayas, earthquakes and their secondary effects like landslides cause loss of life and destruction of infrastructure. With an increasing population, the events are exacerbated. Landslides triggered by earthquakes such as those occurring in 2006 and 2011 have caused casualties by damaging houses and roads, e.g. in the NE Indian towns of Mangan and Chungthang (Figure 1). This project proposal focuses on identifying natural rock slopes that can fail, classify them based on a hazard and risk analysis adapted to seismically active regions, and propose mitigation solutions. This will facilitate effective land-use planning, considering the primary and secondary consequences of landslides.

The identification and hazard assessment of unstable slopes is based on a multidisciplinary approach involving field survey, remote sensing, GIS analysis, cosmogenic nuclide dating, as well as on site displacement measurement and InSAR analyses.

During the projects first field campaign TLS data on active landslides, landslide scarps and landslide dams were collected. Rock samples for cosmogenic nuclide dating of previous events were gathered, once analyzed these will create a better understanding of the landslides recurrence interval in the area.

FOSSILISATION BY MG-CALCITE: MINERALIZED MICROBES(?) IN METHANE-DERIVED CARBONATES FROM THE VESTNESA RIDGE, OFF WESTERN SVALBARD

Tobias Himmler^{1,5}, Richard Wirth², Tõnu Martma³, Gerhard Bohrmann⁴, Stefan Bünz⁵, Jochen Knies^{1,5}, Aivo Lepland^{1,3,5}

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Offshore western Svalbard, methane-derived authigenic carbonate rocks were sampled from the seabed of the Vestnesa Ridge in 1200 m water depth using a remotely operated vehicle, and from 23 meters below the seafloor with the MeBo seafloor drill rig. Negative $\delta^{13}\text{C}$ -carbonate values as low as -36‰ VPDB indicate carbonate precipitation induced by microbial mediated sulphate-dependent anaerobic oxidation of thermogenic methane (AOM). Back-scatter scanning electron microscopy (SEM) of polished thin sections revealed abundant clusters of 10 to 30 μm sized spherical and grape-like structures cemented in aragonite. The structures resemble in size and shape microbial aggregates of AOM-mediating methane-oxidizing archaea and sulphate-reducing bacteria. Element mapping using SEM energy dispersive X-ray analysis of these structures revealed that they comprise finely layered ($< 5\mu\text{m}$) magnesium-calcite.

Here we show the results of high-resolution focused ion beam-transmission electron microscopy (FIB-TEM). The FIB-TEM technique allows nanometre scale characterization of the mineralogical and elemental compositions of these structures. These results help to better understand the fundamental mechanisms of microbial mineralization in methane-derived carbonates.

TAFONI AND WEATHERING PIT GROWTH RATE AND CONTROLLING ENVIRONMENTAL FACTORS IN MARITIME CLIMATE, VÅGSØY, WESTERN NORWAY

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The outermost coast on Vågsøy (61° 55' N, 05° 11' E), west-central Norway, hosts a striking assemblage of cavernous weathering phenomena. These phenomena include alveoli, honeycomb, tafoni and weathering pits, which resemble 'gargoyles' in areas of intense pitting. The morphology and size of the cavernous weathering features are strongly dependent on lithology. Alveoli and tafoni (honeycomb) develop preferentially in mafic rocks, such as dolerite and meta-gabbros, and range in size from cm-scale alveoli to 160 cm deep caverns (tafoni) with large overhanging sections. Weathering pits, developed in augengneiss, are less spectacular with a maximum depth of about 40 cm and less pronounced cavern morphology. The depth of tafoni is correlated ($R^2 = 0.65$) with elevation, however, only weakly related to the distance to the sea. Lithology and topographic position (shielding) seem to contribute to large variations in tafoni size.

Cosmogenic nuclide data obtained from boulders and bedrock surfaces, which locally preserve glacial striae, indicate that the bedrock was significantly glacially eroded during the last glacial cycle. The formation of the observed weathering phenomena must therefore postdate deglaciation, suggesting high weathering rates of up to 0.1 m/ka. The maritime climate with strong wind and high amounts of precipitation produces ample sea spray and aerosols, which evaporate after deposition on rock surfaces and fractures. The expansion of deposited salt crystals leads to a physical disintegration of the bedrock, also known as salt weathering (haloclasty). The correlation of tafoni size with elevation can thus be explained by more frequent wetting-drying cycles at higher elevation, in contrast with more continuously moist condition at lower elevations.

NOT ALL CARBON-FOOTPRINT CALCULATORS ARE CREATED EQUAL – DUCKY ECO'S SOLUTION

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Specialised carbon footprint calculators are vital in assisting individuals, governments, and industries to reduce their carbon emissions. To show the individuals impact calculations need to be done from a consumption-based perspective including the lifetime cycle assessment of products and services. Most organisations' carbon footprints are currently calculated from a territorial perspective meaning they show the carbon emissions emitted in a specific area, rather than the emissions people's choices cause globally. To allow for company growth and an increase in impact, the current calculator needs to be developed for an international market. Difficulties with this include: the vast amount of information to be gathered; differences in nationalised information gathering, including its accuracy and assumptions; language boundaries; the complicated nature of consumption-based footprint calculation and lack of publicly available, information. A carbon footprint calculator for Norway has successfully been created. The USA, UK, and Australia have been chosen as the next countries due to their market potential, shared language, service based economy and climatic differences. Service based economies have the largest difference between consumption-based carbon footprint and territorial-based carbon footprint size. Once research is at a stage where consumption-based carbon footprints can appropriately be determined for these countries, then these results will be compared with territorial carbon footprints. Research has shown a need to expand the current calculator's considerations to include air-conditioning and the fuel type used by households. This influences the significant differences in average household energy use. UK has the lowest levels of use - 17690 kWh per year, then USA with 11978 kWh used per year, then Norway with 20350 kWh per year and Australia has much greater usage rates of 195766 kWh per year.

SELECTED THREATS TO THE QUALITY OF GROUNDWATER IN NORTHERN POLAND AND WAYS TO DEAL WITH THEM

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On the territory of Poland, in most cases, water supply is based on groundwater intakes. Particularly, this is due to the fact that these waters have captured lower content of impurities than surface waters. However, there are many sources of pollution that pose a threat to the quality of groundwater. Sources of pollution can be divided into anthropogenic and geogenic ones. I will show one example for anthropogenic and one for geogenic pollution in northern Poland and and I will show the ways of limiting these pollutants in captured groundwater. An example of the anthropogenic source of groundwater pollution will be presented with the groundwater intake in Bąkowo, located in northern Poland in the direction of water inflow from the landfill site. The simulation of three variants of the work of the intake with a ModFlow modeling program (McDonald, Harbough, 1988) from the GMS 8 (Groundwater Modeling System) package will be presented. These variants assume alternating work of a well or team work with different performance distribution of individual wells. As a result of model tests, an optimal solution for the work of the intake will be presented, which will not cause the launch of water from the landfill site. An example of a geogenic pollution is the problem of ingoing brackish water from the sea to freshwater. These groundwater intake are located in Władysławowo in northern Poland. Underground water is used by the fish factory in the process of fish processing for technological purposes, for cleaning fishing boats and for people to drink in a large hotel located in Wladyslawowo. The risk of deterioration in the quality of water is due to the fact that with the increase in water abstraction, the concentration of chloride ion in the water is increased. This is a big problem

since during the summer the collection of groundwater in this region is almost twice as high as in winter due to its tourist character.

The method of dealing with the threat of ingression of brackish water to fresh water through the exploitation of a barrier well, which has the task of absorbing brackish water, will be presented.



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