NORSK GEOLOGISK FORENING

Number 1, 2021

ABSTRACTS AND PROCEEDINGS

OF THE GEOLOGICAL SOCIETY OF NORWAY

GEOSCIENCE IN A CHANGING WORLD ▮ 6.–8. 01.2021

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Edited by: Hans Arne Nakrem and Ann Mari Husås

34TH GEOLOGICAL WINTER MEETING.

GEOLOGI.NO

VINTERKONFERANSEN 2021

ISBN: 978-82-8347-049-2

NGF Abstracts and Proceedings
NGF Abstracts and Proceedings was first published in 2001. The objective of this series is to generate a common publishing channel of all scientific meetings held in Norway with a geological content.

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c/o Norges Geologiske Undersøkelse
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Published by:
Norsk Geologisk Forening
c/o Norges Geologiske Undersøkelse
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GEOLOGICAL SOCIETY
OF NORWAY

of magmatism cannot be easily be explained by passive decompressional melting of sub-lithospheric mantle with a normal potential temperature. New constraints on 1) melting conditions, 2) timing of magmatism, 3) spatial and temporal variations, 4) eruption environment, 5) sedimentary proxy data, 6) temporal resolution of magmatism and climate change events are required to resolve current controversies. Systematic IODP drilling is a way to provide these constraints and will allow the development of a quantitatively testable framework for volcanic rifted margin formation and consequences for global climate change. The proposed drilling strategy is a series of shallow boreholes along and across the Mid-Norwegian margin. New 3D seismic data collected by the industry and academia during the past few years have provided unique imaging of the basalt and sub-basalt sequences and allowed for optimal planning of the drill sites for scientific purposes. Additional holes are located along and outboard of the continent-ocean boundary to constrain the temporal evolution of the breakup magmatism.

Characterization of reservoir compartmentalization using strontium Isotopes

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Routine measurements of formation pressure while drilling reservoirs can indicate the presence of internal barriers to vertical fluid movement when there is a sudden shift in the pressure data. However, pinpointing the location of a barrier is often not possible since the density of pressure measurements is low and irregular. The aim of this contribution is to show how geochemistry can help to pinpoint the precise location of a barrier. As an example, we use a 25 m thick interval within the Middle Jurassic Hugin reservoir unit of the Langfjellet oil discovery on the Norwegian Continental Shelf. The location of the barrier is constrained by the upper and lower pressure measurements and could correspond to any of the several layers of silt, shale or coal layers in this interval. In this study, we collected every 2-4 m a total of 39 samples from a 110 m long cored section of a technical side-track well over the available. Each sample was prepared and analyzed using the SrRSA method (Strontium Residual Salt Analysis), which measures the $^{87}Sr/^{86}Sr$ ratio in salt residue that precipitated in the pore space after the core dried out. The $^{87}Sr/^{86}Sr$ is a natural tracer because the ratio is not affected by mass fractionation. The $^{87}Sr/^{86}Sr$ in rocks is mostly acquired by water-rock interactions during diagenesis and evolves through mixing and equilibration of different water bodies, unless low-permeability barriers prevent equilibration. Therefore, the SrRSA patterns observed in the well represent a 1D snapshot of the fluid dynamics at the time of oil filling, which is a frozen image of competing equilibrium vs disequilibrium conditions. The SrRSA data follow a smooth trend of content values at 0.713 and display a sudden jump to lighter 0.709 values near the top of the 25 m thick interval that suggests the presence of a potential barrier. The lithological core log shows that the SrRSA step change corresponds to a coal-shale unit, which is interpreted to represent the barrier. The SrRSA data further demonstrate the reservoir unit at Langfjellet does not contain any other barriers to fluid flow, since pressure equilibration could have masked a possible compartmentalization. This study shows that the SrRSA method is a powerful tool that helps to locate the precise location of a barrier causing pressure differences between adjacent or superposed compartments. Finally, the RsRSA can also be used to confirm communication since homogeneous pressure may either indicate fluid connectivity or pressure equilibration across barriers.

Multi-scale influence of topography on shallow-marine successions associated with long-term transgressions: from Argentinean outcrops to the Norwegian shelf subsurface

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Thick shallow-marine successions associated with long-term transgressions are less well known than their thin, well-sorted counterparts, more widely studied due to their potential to form good reservoirs. In these successions, particularly in storm-dominated examples, bioturbation can obliterate primary sedimentary characteristics, making stacking patterns and sequences difficult to define, and challenging our understanding of the main controls in their resulting depositional architecture. This study presents an example from the Jurassic of the Neuquén Basin (Argentina), with the aim to: a) refine the depositional model of a thick, shallow-marine succession associated with a long-term, early post-rift transgression, b) constrain multi-scale controls on stratigraphic architecture and lateral facies variability, and c) discuss their preservation and response to post-depositional processes. To do this, a <300 m-thick succession has been studied along a >10 km continuous exposure, with geological mapping, sedimentary logging and correlation of stratigraphic units, integrated with subsurface, biostratigraphic and ichnological data. The succession shows an overall retrogradational-aggradational-retrogradational stacking pattern, with several higher frequency regressive units (parasequences and parasequence sets, PSS). The lower part (PSS I) comprises laterally-discontinuous (10's of m) mouth-bars and distributary channel fills, dominated

by several m-thick coarsening- and fining-up sandstone packages and m-scale erosive conglomeratic lenses. Above these, the succession (PSS II-IV) is composed by laterally-continuous (>100's of m) storm-dominated lower-shoreface to upper-offshore deposits, dominated by <1m-thick fine-grained and highly bioturbated tabular muddy sandstones and sandy mudstones, with rarely-preserved HCS and bioclastic-rich limestones; their internal characteristics and bed boundaries are diffuse due to pervasive bioturbation, suggesting overall low sedimentation rates and recurrent periods of colonization. The coarse-grained nature and lithology of the mouth bars and channel fills in the lower succession (PSS I) are consistent with a proximal sediment source, associated with erosion of intra-basinal highs. Its variable thickness, lateral distribution and onlap against underlying syn-rift deposits demonstrates partial infill of localized higher-accommodation areas. The well-sorted and finer-grained nature of the shoreface-offshore strata the middle and upper succession (PSS II-IV) indicates a more mature, distal source, with sediment redistributed by longshore currents, and then intensely bioturbated. These deposits display well-defined parasequences internally composed of laterally-continuous bedsets (<5 m-thick). They extend along the entire study area, but show a significant vertical thickness variability. The integration of outcrop and subsurface data (well and seismic) reveals the long-term transgression occurred over a complex, regional-scale ramp-step and underfilled rift topography, which controlled the location of main thickness and facies changes, and promoted areas of favored biogenic reworking. This study offers new insights in how to interpret thick transgressive successions based on primary depositional mechanisms and postdepositional processes, and provides useful tools to understand and predict the nature and potential preservation of these deposits in limited subsurface datasets.

First results from the Skutshorn rock slope instability, Vang municipality, Innlandet

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The Skutshorn rock slope instability is located along the NE shore of Vangsmjøse. A thrust fault divides the Vangsdekket (phyllite) in the footwall with the Valdres-sparagmite (arkose, quartzite, and mica schists) of the hanging wall. The instability was discovered during reconnaissance from aerial photos and verified to be an active instability during the first field campaign in 2018. InSAR analysis using data from the Sentinel-1 satellites (https://insar.ngu.no) indicate that velocities vary significantly over the instability with an average of 2 cm/yr in the upper part and 0.5 cm/yr in the scree deposits along the shore of Vangsmjøse. The highest velocities have been documented in the middle part, where the instability is strongly fractured into individual blocks of several tens of meters diameter. Periodic dGNSS surveys (using points installed by NGU), as well as ground based InSAR campaigns by NVE in 2019, agree with the satellite data. The road authorities recorded several small rockfalls between February 2019 and June 2020. On October 12th, 2019, a rockfall came down the slope from approximately 550 meters above the lake level. The material reached the lake, covered, and blocked the road over a stretch of 100 meters and left it closed for almost three days.

Our preliminary data suggest that the instability comprises at least four different failure scenarios, with two self-standing scenarios in the front and one scenario in the central part. We also consider the possibility that the entire slope can also be combined into a single large scenario that even might continue below the waterline.

The volume of the frontal scenarios, as determined by SLBL and PLANOS, is in the range of 100 000 to 1 million cubic meters. The model of the potential runout of both were calculated using DAN3D with frictional rheology using a low pore pressure and friction angle ranging from 25º to 32º for basal friction. The results indicate that both scenarios would reach the lake. Data processing in the next weeks will help to define the other scenarios. This will be complemented by bathymetric mapping of Vangsmjøse to delimit the entire instability and to map out events of potential earlier catastrophic failures.

Groundwater flow patterns predicti-on using unsupervised machine learning

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A database of more than 3000 water samples taken along the Somali territory has been stored for more than 30 years without making further use of it. The water chemical composition database built by C. Faillace in 1986, is a compilation of more than 100 technical reports and unpublished documents from the 1983 and 1986 period.

FAO SWALIM and other organizations have conducted more recent and detailed surveys but are limited to certain areas for security reasons. This database has about 300 samples, which overlap with some water sources that were previously reported and analyzed by Faillace in 1986.

The main objective of this study was to understand whether these databases were useful to predict ground-water flow patterns. The initial approach using piper diagrams showed that it was possible to classify water types and quality from the main six ions, but it was not conclusive for flow patterns predictions; the samples are too many but not enough per square kilometer.

Since lithology plays an important role on water composition, a second approach was to run an unsupervised model to find similarities and to group water samples from the main six ions to infer its provenance. The first run provided four different groups that were analyzed in connection with the surface geology. The model was refined and lead to re-