Presentations

"Magnetotellurische und reflexionsseismische Daten im Umfeld des Schlammvulkans North Alex, West-Nil-Delta – erste Ergebnisse", Poster, German Geophysical Society conference, 23rd -26th March 2009, Kiel, Germany (poster)

"Combined Controlled Source Electromagnetic, Reflection Seismic and Borehole study at the shallow-water edge of gas hydrate stability offshore Vancouver Island, IODP Expedition Site U1329", Poster, International Conference on Gas Hydrates, July 17-21, 2011, Edinburgh, UK (poster)

"Controlled source electromagnetic study on the response of cold vent sites and gas hydrate occurrences on the northern Cascadia margin", AGU fall conference, Poster OS43B-1812, San Francisco, USA (poster)

"1-D Bayesian inversion of marine time-domain controlled source electromagnetic (CSEM) data", Poster, Marine electromagnetics conference, 16th-19th July 2013, Hamburg, Germany (poster)

Publications


The Final Oral Examination
for the Degree of

DOCTOR OF PHILOSOPHY
(School of Earth and Ocean Sciences)

Romina Gehrmann
Dipl. Geophysicist (2008, University of Leipzig, Germany)

"Non-linear Bayesian inversion of controlled source electromagnetic data offshore Vancouver Island and in the German North Sea"

Monday, November 3rd, 2014
8:30 am
Bob Wright Centre (SCI), RM A319

Supervisory Committee:
Dr. Michael Riedel, Geological Survey of Canada, UVic (Co-Supervisor)
Dr. Stan E. Dosso, SEOS, UVic (Co-Supervisor)
Dr. George D. Spence, SEOS, UVic (Member)
Dr. Maycira Costa, Department of Geography, UVic (Outside Member)

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Dr. Karen Weitemeyer, Ocean and Earth Science, National Oceanography Centre Southampton
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Chair of Oral Examination:
Dr. Terry Prowse, Department of Geography, UVic
Abstract

This thesis examines the sensitivity of the marine controlled source electromagnetic (CSEM) method to sub-seafloor resistivity structure, with a focus on gas hydrate and free gas occurrences. Different analysis techniques are applied with progressive sophistication to a series of studies based on simulated and measured data sets. CSEM data are modelled in time domain for one-dimensional models with gas hydrate, free gas and/or permafrost occurrences. Linearized and non-linear inversion methods are considered to infer subsurface models from CSEM data.

One study applies forward modelling and singular value decomposition to estimate uncertainties for permafrost models of the Beaufort Sea. This simulation study analyzes the resolution of the CSEM data for shallow water depth which is a challenging case because the electromagnetic signature of the air-water boundary may mask the sub-seafloor response. The results reveal a blind window as a function of water depth in which the CSEM data are insensitive to the sub-seafloor structure. However, the CSEM data are sensitive to the top and the bottom of the permafrost with increasing uncertainties with depth.

The next study applies non-linear Bayesian inversion to CSEM data acquired in 2005/2006 on the northern Cascadia margin to investigate sub-seafloor resistivity structure related to gas hydrate deposits and cold vents. Bayesian inversion provides a rigorous approach to estimate model parameters and uncertainties by probabilistically sampling of the parameter space. The resulting probability density function is interpreted here in terms of posterior median models, marginal and joint marginal probability densities for model parameters and credibility intervals. The Bayesian information criterion is applied to determine the amount of structure (number of layers) that can be resolved by the data. The parameter space is sampled with the Metropolis-Hastings algorithm in principal-component space. Non-linear, probabilistic inversion allows the analysis of unknown acquisition parameters such as time delays between receiver and transmitter clocks or unknown source amplitude. The estimated posterior median models and credibility intervals from Bayesian CSEM inversion match the seismic reflector related to the contrast between the two depositional environments.

The CSEM survey targeted a strong, phase-reversed, inclined seismic reflector within the glacial sediments, potentially indicating free gas. While interface-depth estimates from CSEM inversion do not correlate closely with this reflector, resistivities are generally elevated above the strong seismic amplitudes and the thickness of the resistive layer follows the trend of the inclined reflector. However, the uncertainties of deeper interface depth estimates increase significantly and overlap with the targeted reflector at some of the measurement sites. Relatively low resistivities of a third layer correlate with sediments of late-Miocene origin with a high gamma-ray count indicating an increased amount of fine-grained sediments with organic material. The interface at the bottom of the third layer has wide uncertainties which relates to the penetration limit of the CSEM array.

Awards, Scholarships, Fellowships

09/2009 – 12/2012 Fellowship of the University of Victoria

07/2010 European Consortium for Ocean Research Drilling Scholarship for IODP-Canada summer school 2010 “Paleoceanography and Paleoclimatology at high latitudes”