

SILL03

Petroleum Implications of Sill Intrusions

Magmatic sheet intrusions and associated hydrothermal vent complexes are common in many prospective sedimentary basins. Such volcanic basins are located along the Atlantic margins, in the Arctic, and offshore Australia.

Petroleum exploration in volcanic basins requires reliable methods for identification and interpretation of intrusive complexes on seismic data, combined with an understanding of how the magmatic deposits and

processes influence the petroleum system.

The SILL03 multi-client report offers new understanding on the petroleum implications of sill intrusions. The report is the result of a comprehensive four-year multi-disciplinary study with the following main themes:

- Seismic imaging & interpretation
- Well analyses
- Fieldwork
- Geodynamic modeling
- Integrated interpretation



Product Information

A **SILL03** project license gives access to research results presented as paper reports, digital files, in-house courses, and field trips.

The people behind the project are leading scientists from universities and research companies. They have expertise in different fields such as petroleum exploration, seismic interpretation of volcanic basins, fluid-rock interaction, and theoretical physics.

Main Report

The main report gives a comprehensive summary of the project results in an A3 atlas format. This report is written for petroleum explorationists who want to know

- how to identify and map sill intrusions on seismic data,
- how sill complexes influence seismic wave propagation and seismic processing, and
- how the magmatic processes and deposits influence petroleum maturation, fluid migration, and trap formation in volcanic basins.

The specific project results are documented in detail in five extensive appendices.

In-House Presentation

We offer a one-day in-house presentation as a part of the project. The presentation may include a workshop based on company data.

Consulting

VBPR can do consulting jobs on proprietary data as an extension to the SILL03 project.

Field Trips

VBPR arrange field trips for petroleum geologists exploring volcanic basins. Field trips are offered to the Karoo basin (South Africa), Iceland, and West Greenland. Please contact VBPR for further information.



Contents - A3 Report

Background

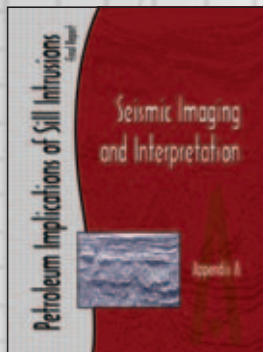
Field Observations

Seismic Imaging and
Interpretation

Well Studies

Geodynamic Modeling

Petroleum Implications



The specific project **results** are documented in five appendices.

Appendix A: Seismic Imaging and Interpretation

Imaging and interpretation of 3D data and >150,000 km of 2D seismic data. Selective re-processing and seismic modeling.

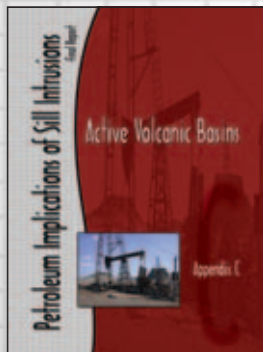
- *Seismic processing and modeling of sill complexes in sedimentary basins (S. Bannister, S. Planke, and Ø. Mjøen, p. 7-59)*
- *Seismic interpretation of sill complexes in the Vøring and Møre basins (T. Rasmussen, S. Planke, and R. Myklebust, p. 62-116)*
- *Seismic interpretation of hydrothermal vent complexes in the Vøring and Møre basins (S.S. Rey, S. Planke, T. Rasmussen, and R. Myklebust, p. 119-184)*



Appendix B: Intrusive Volcanic Complexes in the Karoo Basin

Results from five fieldwork campaigns and three industry field trips to the Karoo basin. Edited by H. Svensen and S. Planke. 178 pp.

- *Geological background*
- *Deep sill complexes and breccia pipes*
- *Saucer shaped sill complexes*
- *Hydrothermal vent complexes*
- *Extrusive complexes*
- *Borehole studies*



Appendix C: Active Volcanic Basins

Results from fieldwork in pierced sedimentary basins.

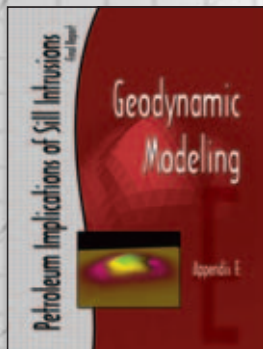
- *Mud volcanism and hydrocarbons in Azerbaijan (S. Planke and H. Svensen, p. 11-39)*
- *The Salton Sea hydrothermal system (H. Svensen, p. 43-53)*
- *The Mali field report (edited by H. Svensen, 90 pp.)*



Appendix D: Well 6607/12-1: Final Report

Comprehensive case study of a hydrothermal vent complex on the Nordland Ridge, Vøring Basin. 139 samples analyzed. Edited by H. Svensen and S. Planke. 175 pp.

- *Core description and petrography*
- *XRD, isotope geochemistry (C, O, Sr), RockEval, TOC, Vitrinite Reflectance*
- *Biostratigraphy*
- *Wireline log analysis*
- *Seismic interpretation and processing*



Appendix E: Geodynamic Modeling

Case studies and theoretical development of new numerical methods.

- *Modeling sill emplacement and hydrofracture (edited by A. Malthe-Sørenssen, 28 pp.)*
- *Modeling formation of hydrothermal vent complexes (edited by B. Jamtveit, 10 pp.)*
- *Modeling maturation effects (edited by A. Kjeldstad, 54 pp.)*

Project Background

The *Petroleum Implications of Sill Intrusions* project was initiated in 1999 during a field trip to the Karoo basin, South Africa. We realized then that there was a need for a comprehensive integrated project to understand the exploration risks and implications of magmatic deposits in sedimentary basins.

A project group consisting of VBPR, TGS-NOPEC, Prof. B. Jamtveit, and Dr. A. Malthe-Sørenssen completed an initial project report in 2000 (SILL00). This report was well received, and led to a two-year follow-up project (SILL01) funded by 10 major oil companies and the government. Both projects have particularly focused on the influence of magmatic processes and deposits on the intruded sedimentary strata.

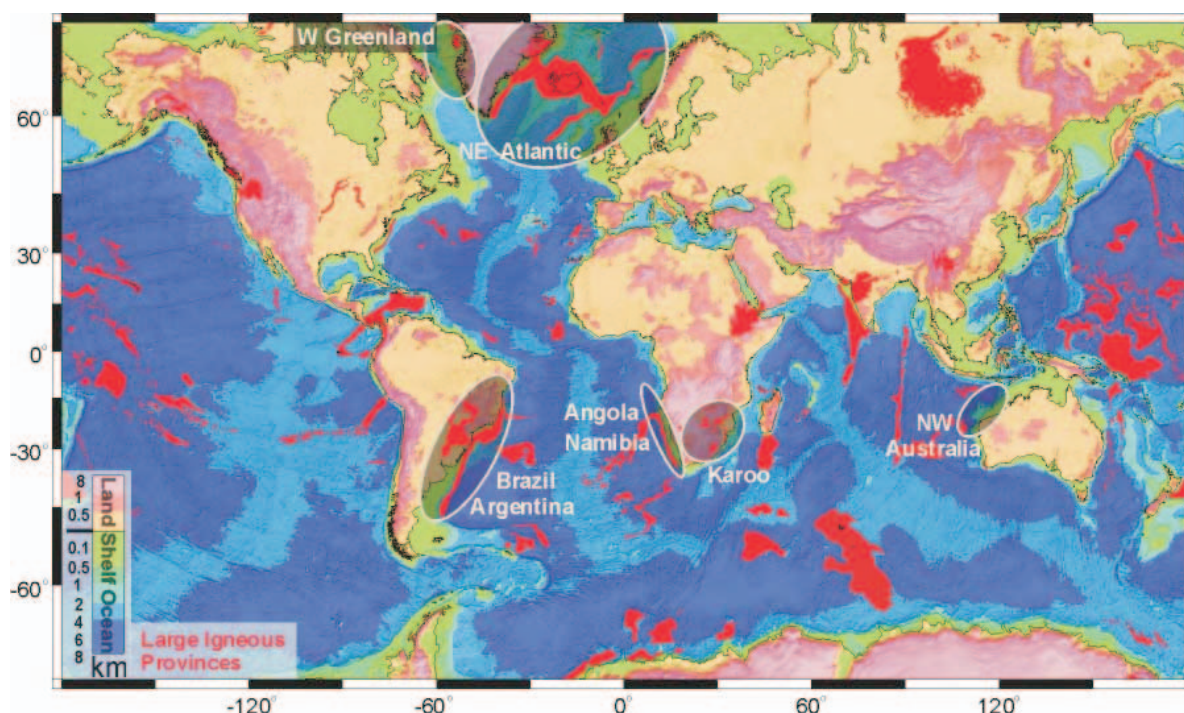
The emplacement of molten rocks into a sedimentary basin clearly has a major effect on the local temperature history. **Heating** of the host rock may cause metamorphic reactions, maturation of organic material, and boiling of pore fluids. We commonly find evidence of this heating event in volcanic

basins, and we have currently mapped almost 1000 onshore and offshore hydrothermal vent complexes formed by **phreatic eruptions** ('steam eruptions'). The emplacement further leads to **deformation** (uplift, faulting) of the host rocks, forming potential traps and fluid migration pathways.

Detailed borehole, field, and seismic studies have shown that the intrusive deposits have a significant **long-term effect** on the basin history. Fluid migration is particularly influenced by the presence of low-permeability sills and high-permeability vent complexes and fracture systems along dikes. Structuring of the basin is also affected by the armoring effect of the sheet intrusions.

The Karoo basin is a unique place to observe and study volcanic intrusive complexes in the field. We use the basin extensively as a **natural laboratory**, and we have also arranged three field trips to the Karoo for more than 50 participants.

relevance



People

The SILL03 project group consists of individuals with a varied and complimentary background in petroleum exploration of volcanic basin, seismic imaging and interpretation, fluid-rock interactions, numerical modeling, and theoretical physics. This varied background has been very important for the success of the project. The main project contributors are:

VBPR: Dr. Sverre Planke, Torfinn Rasmussen, Sebastian S. Rey, Ellen E. Planke, and Kim Larsen

TGS-NOPEC: Øyvind Mjøen and Reidun Myklebust

PGP: Prof. Bjørn Jamtveit, Dr. Anders Malthe-Sørenssen, Dr. Henrik Svensen, Prof. Yuri Podladchikov, Camilla Håve, and Siri Ann Lorentzen

Other: Dr. Steven Bannister (GNS, New Zealand), Dr. Luc Chevallier (Council for Geoscience, South Africa), Dr. Arild Kjeldstad (University of Oslo); Prof. Julian March (Rhodes University, South Africa)



people