COMPARISON OF BASIN MODELING TOOLS FOR PRESSURE PREDICTION

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Abstract

This paper concerns the outline of a project for the independent comparison of the performance of different basin modeling tools for pressure prediction. The deliverables of the project will include standard test data sets and test models, results of benchmarking and comparison tests, and a best practice guide for the application of basin modeling for pressure prediction. The outcome of the project is intended for the benefit of users of basin modeling tools as well as for software developers.

Motivation

The development of basin modeling started more than 25 years ago with 1D numerical simulation programs focussed on reconstructing the temperature and maturity history of source rocks. Later 2D and 3D basin modeling tools aimed for a more comprehensive simulation of the many interrelated basin processes that lead to oil and gas accumulations. Basin modeling tools were traditionally used to study the petroleum system at basin and regional scale. In recent years, the comprehensive basin modeling tools are also used for prediction and process-based understanding of fluid pressures in order to estimate, for example, safety and economic risks of drilling (Düppenbecker 2004, Verweij 2003, Verweij et al 2004).

There are a number of unsolved questions related to the application of basin modelling for pressure prediction, resulting from:

- A **lack of standardisation** which hampers the comparison of basin modelling results for different commercial packages. The differences in the packages concern, for example: the default relations between lithology and properties through different compaction approaches and porosity-permeability relations; lithology mixing rules/scaling rules used to calculate bulk permeability and anisotropy; water properties; boundary condition options; and increasingly the introduction of special features such as fractures, faults, cementation, gas generation.

And,

- The **unclear applicability of the default set-up** included in the basin modeling packages for different types and ages of sedimentary basin and in different parts of the world. Default set-ups concern, for example, the standard lithologies and their default properties, default compaction equations and compaction parameters, default porosity-permeability relations.
- The **absence of a complete overview of the limiting assumptions and conditions** underlying the different basin modeling programs and their theoretical framework.
- A **lack of standardized workflow** for the application of basin modeling tools for pressure prediction.

In addition there is room for improvement of the hydrogeologic and hydrodynamic behavior of the models.

The project has the potential to solve these problems and contribute to the development of new modeling features.

Objectives

- Development of a comprehensive set of standard test models and associated test data
- Independent comparison of the performance of different basin modeling tools for pressure prediction. The focus is on evaluation of the theoretical behavior of the basin modeling tools.
- Compilation of a best practice guide for the application of basin modeling for pressure prediction.

In addition, the project intends to initiate, support and perform R&D to improve the hydrogeologic and hydrodynamic behavior of the models.

Project planning

The project will be carried out in phases. The first phase (duration 1 year) provides the general basis for the project. This includes a comprehensive set of standard test models (analytical solutions to simple 1D/2D hypothetical test problems, 1D/2D/3D hypothetical test models and

associated synthetic data sets) and a case study data cube of a selected part of the Netherlands North Sea. TNO will develop and test the data sets and test models.

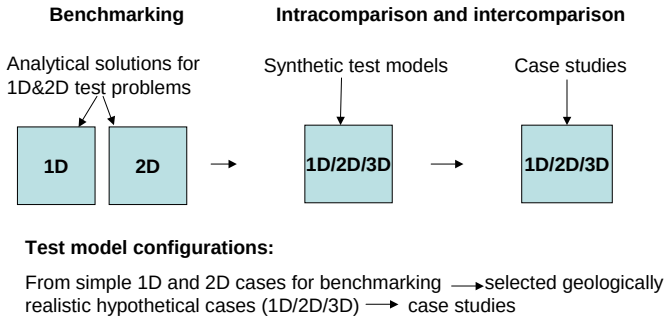

Figure 1 Testing program

The comprehensive set of standard test models and the case study data cube are used in the second phase of the project for the independent comparison of different basin modeling tools for pressure prediction. The comparison and evaluation of the results of pressure simulations with test data sets and test problems and case study data using different basin modeling tools will be carried out by TNO. The 3D case study data offer opportunities for a possible extension of the project (third phase of the project), involving the development and testing of new modeling features simulating pressure influencing processes and characteristics in the case study data cube.

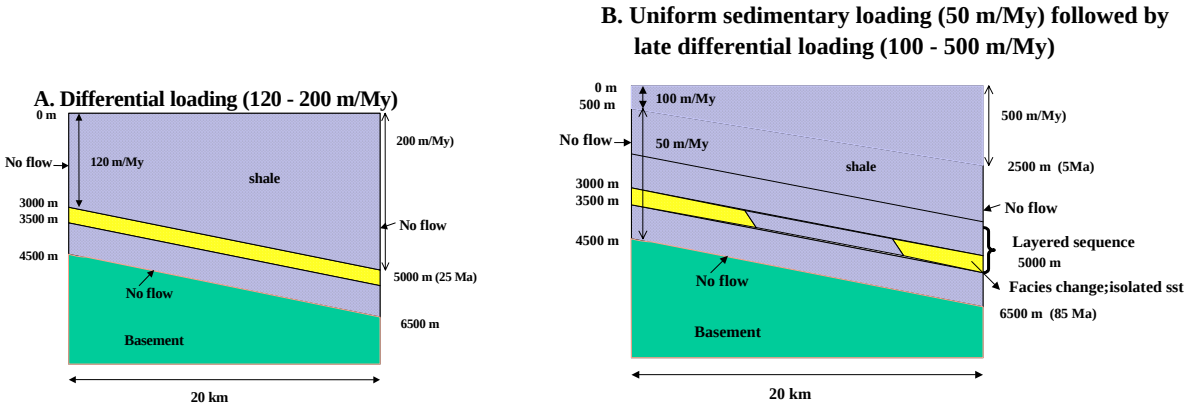

Figure 2 Example synthetic test models: A. Differential loading shaly basin with sandstone layer; B. Differential loading and facies change

Project deliverables

- Base cases for 1D and 2D benchmarking using analytical and semi-analytical solutions to hypothetical test problems
- Synthetic data sets and hypothetical test problems for 1D/2D/3D intracomparison and comparison of basin modeling tools
- Case study data cube for comparison of basin modeling tools and for developing new modeling features
- Results of benchmarking, intracomparison and intercomparison of different basin modeling tools for pressure prediction
- Best practice guide for application basin modeling for pressure prediction
- Web site for exchange of ideas, data and intermediate products

Consortium membership

Project participation is open to users and developers/vendors of basin modeling tools:

- Geoscience software vendors and development organizations (commercial simulators)
- Petroleum industry (in-house developed simulators)
- Universities (research simulators)
- Research institutes (research simulators)

Start of project

For - financial - support, we are looking for 5-10 petroleum industry members that are willing to participate in the project. The project will start if a minimum of 5 industry members sponsor the project.

References

Düppenbecker, S.J. 2004. The role of multi-dimensional basin modeling in integrated pre-drill pressure prediction. *AAPG Annual Meeting, Dallas USA, April 18-21, 2004*.

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