The influence of fluvial reservoir architecture on geothermal energy production in Hot Sedimentary Aquifers

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Currently six geothermal doublets are realized in the WNB. Five of these doublets target the same Lower Cretaceous fluvial sandstone interval, the Nieuwerkerk Formation. About 40 exploration licences are granted. Many of them also have sandstones in the same fluvial interval, the Nieuwerkerk Formation as a target. To successfully and efficiently produce geothermal energy from this fluvial sandstone interval, the distribution and internal architecture of the sandstone bodies must be better understood.

Fluvial sandstone reservoirs are composed of stacked meander belts and floodplain fines. Net-to-gross, orientation and stacking pattern of the channel belts is of major importance for the connectivity between the injection and production wells in fluvial sandstone reservoirs.

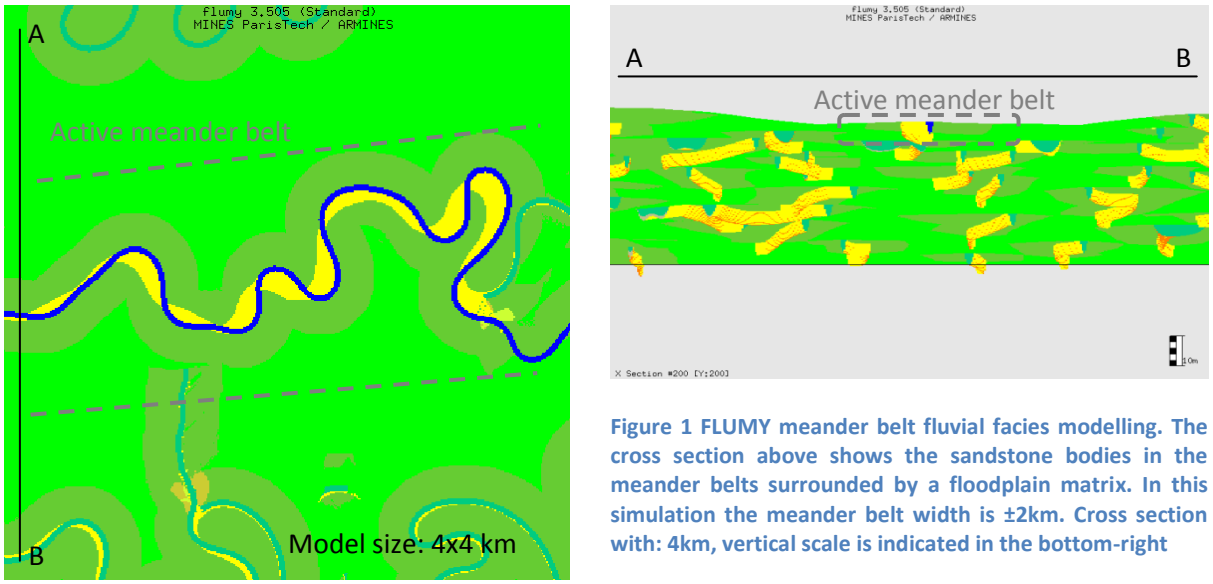

Figure 1 FLUMY meander belt fluvial facies modelling. The cross section above shows the sandstone bodies in the meander belts surrounded by a floodplain matrix. In this simulation the meander belt width is ±2km. Cross section with: 4km, vertical scale is indicated in the bottom-right

The influence of fluvial reservoir architecture is investigated in this project on two levels:

1. Flow through a single meander belt
2. Stacking pattern of meander belts forming the fluvial reservoir

<u>Flow through a single meander belt</u>

In order to identify the most influential geological features controlling the flow and heat transfer in geothermal aquifers, several reservoir models of a meander belt are constructed with increasing geological detail. These models are based on the results of geological fieldwork on the Huesca fluvial fan in Miocene, Ebro Basin, Spain.

Several 2D models with different geometry of the fluvial sandstone bodies, property distribution and well placement within the channel belt will be considered. In 3D models orientation of the channel belts and stacking patterns of the channel bodies are considered.

A finite-element approach is utilized to study the geothermal energy production. The effects of different levels of architectural complexity on the geothermal energy production, by conducting several accurate numerical simulations, are discussed. The results show that utilizing simplified reservoir models can lead to a significant error in predictability of the heat recovery from deep fluvial sandstone formations.

Stacking pattern of the meander belts

In a second phase the connectivity of the stacked meander belts of the Nieuwerkerk Formation will be investigated. Static models on kilometre scale will be created with different meander belt stacking patterns. Properties of the meander belts will be upscaled in these models. With these models pressure build-up tests and interference test can be simulated. The goal of these test simulations is to show how well test and interference tests could give more insight in the stacking pattern and property prediction of the meander belts of the Nieuwerkerk Formation. In addition this will be combined by showing the results of these tests on life-time predictions for geothermal doublets and interference risks between future adjacent doublets.

Different models of the sandstones of the syn-rift Nieuwerkerk Formation are used. Van Adrichem Boogaert & Kouwe (1993-1997) divided the Nieuwerkerk Formation in the West Netherlands Basin into the Alblasserdam, Delft Sandstone, and Rodenrijs Claystone members. The Delft Sandstone Member was interpreted as stacked distributary-channel deposits in a lower coastal-plain setting. DeVault & Jeremiah (2002) did not recognize this member as a separate stratigraphic unit because thick, stacked channel complexes occur throughout the formation. The difference between the two models is sketched in Figure 2. This has influence on the success of many geothermal licences and also on the interference between the licences.

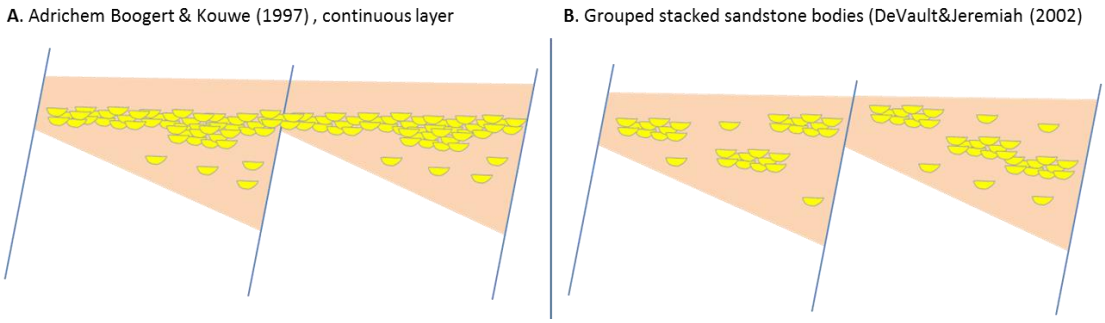

Figure 2 Delft sandstone model of Adrichem Boogaert & Kouwe (1997) (A) on the left and the model of DeVault and Jeremiah (2002) on the right (B).

References

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