3D Modeling of the Flemish subsurface using GOCAD software (Bos, S., 2014)

INTRODUCTION

The project to remodel the deep subsurface of the Campine Basin area (Figure 1) was started by ALBON (Land and Soil Protection, Subsoil, and Natural Resources Division of the Flemish Government) with the aim to disseminate the available information to the general public and to enable ALBON to develop a strategy to manage and valorize the natural georesources (hydrocarbons, energy storage, geothermal energy,…) in an efficient and sustainable way. The framework of this modeling exercise is the VLAKO (Flemish Subsurface Knowledge Center) taskforce. In 2013 a first balanced 3D model of the Flemish subsurface (Matthijs et al., 2013) and a 3D geoviewer tool were launched to the public making use of a modified version of the 3D SubsurfaceViewer® software from INSIGHT GmbH.

In this current model, faults are not present as modeled fault planes. Instead, fault throws have been introduced by using existing base Cretaceous fault maps and extending these faults in vertical direction to top Cretaceous and to the base of the model. Into the younger Cenozoic strata, these faults are then extrapolated using an arbitrary angle of 70°.

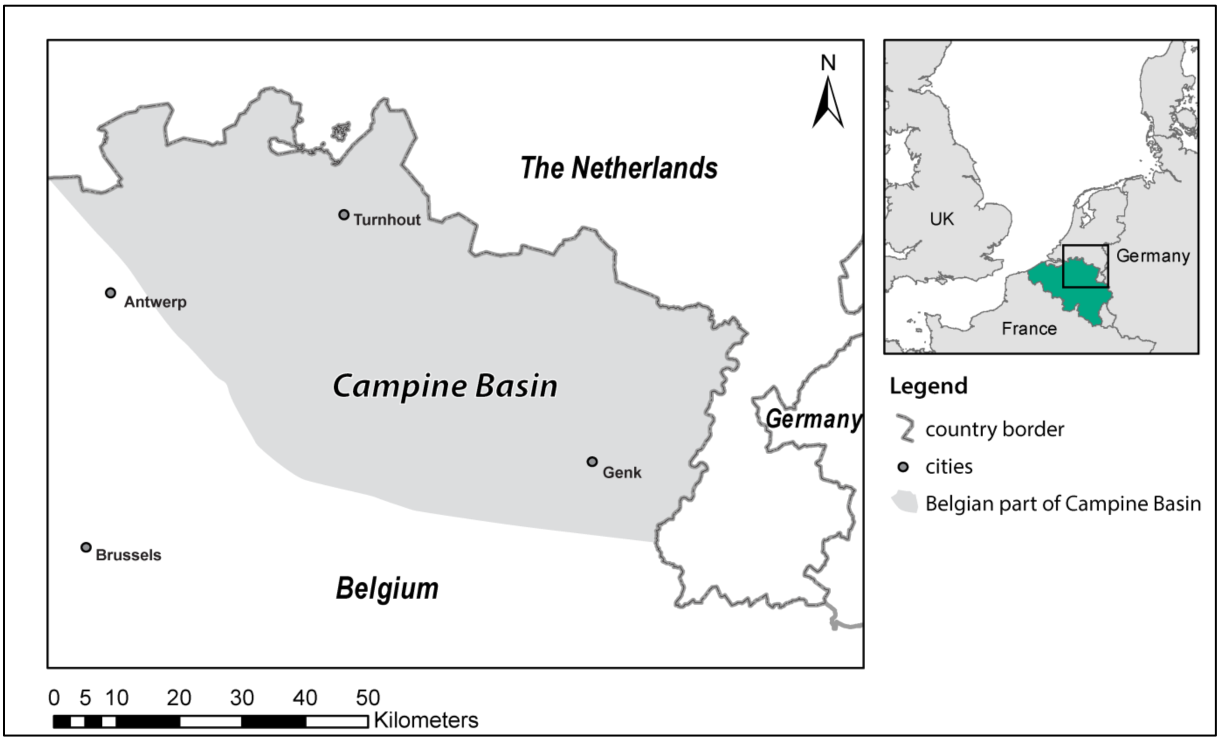

Figure 1: Location map of the Campine Basin area in the NE of Belgium

The location of faults in the subsurface of the Campine Basin (NE Flanders) was compiled for the first time in 2000 by Langenaeker. Although that study was based on all seismic data available at that time, the fault pattern is rather ambiguous in some areas and is therefore hard to explain with paleostress regimes.

METHODOLOGY

Since the beginning of 2014, VITO's (Flemish Institute of Technological Research) VLAKO-team, is using a new methodology in modeling the deep subsurface of Flanders. As a step-up to full voxel models containing several static parameters, VITO started analyzing all available seismic data in order to create a solid fault model. The preliminary results of the reinterpretation of all seismic data, digitally available for the Campine Basin, is given at this stage.

The interpretation of this solely 2D seismic has been performed in the GOCAD software, developed by Paradigm. The subsequent structural modeling is also executed in the same package, making the workflow more efficient than before, without the need of exporting and importing intermediate results from one software package to another.

Since also a velocity model was created in the same software package, well stratigraphic interpretations are merged with the seismic interpretations to come up with a full structural model containing all regionally important faults and horizons.

RESULTS

Consistent with earlier studies (Dreesen et al., 1987, Langenaeker, 2000), clear graben structures were recognized in the western Campine Basin. Furthermore, the Ruhr Valley Graben boundary faults with the largest throw and the location of fault(s) with a large throw in the north of the Campine area have been consistently recognized. However, this study differs from the previous studies in two key ways.

First, in the north of the Campine Basin, one does not concentrate all fault activity on one E-W-oriented fault, known as the Hoogstraten listric fault (Vandenberghe , 1982), instead the strong northwards deepening of the Dinantian and Namurian intervals is divided over a set of at least five faults. In addition, one recognizes faults with a similar orientation in the southern Campine Basin.

Second, Ruhr Valley Graben faults are interpreted to persist over larger distances with only slight changes in orientation due to cross-cutting WNW-ESE faults. Step-overs encountered in some areas are interpreted to be the result of the connection of three fault segments from different faults.

The recognition of WNW-ESE patterns over larger areas is in agreement with interpretations made on the Dutch side as part of the West Netherlands Basin (Duin et al., 2006) and coincide with the general orientation of the Brabant Massif, indicating an older, Caledonic origin. The Hoogstraten fault, which has the largest throw of all WNW-ESE faults in the Belgian part of the Campine Basin, is probably a reworked Dinantian shelf edge fault.

DISCUSSION

Yet, despite our understanding of the overwhelming benefits of interpreting seismic data in 3D windows using state-of-the-art software, controversy still remains regarding the extension of faults over large distances. It is our view, however, that long-distance faults with variable throws give rise to a pragmatic fault model that can be used for burial history reconstructions and horizon restorations.

Although seismic interpretations of the Cenozoic strata have been performed recently in the Ruhr Valley Graben (Deckers et al., 2013), an extension of the interpretations of Cenozoic strata outside the Graben will be of great importance in understanding detailed fault activity. Concerning the Hoogstraten fault, it remains an open question as to how far the faults continue in depth. The drilling of a new well to the top Dinantian in this area could resolve this enigma.

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