Geological interpretations

The structural 3D model facilitates the reconstruction of the tectonostratigraphic development of the Netherlands.

Structural elements

Structural element maps have been constructed from the depth and present-day thicknesses of the different stratigraphic layers in the 3D model (figure on the right). The elements are divided into structural highs, platforms and basins. Most basins are inverted during the Alpine orogeny.

Tectonostratigraphic observations include:

- Platforms and highs experienced less structural deformation during the major phases of rifting. Halokinesis in the platform areas is thin-skinned in the sense that it is decoupled from subsalt faulting.
- In the rift basins salt diapirs and walls are almost exclusively linked to major subsalt faults. Halokinesis in the basin areas is thick-skinned, i.e. importantly controlled by subsalt deformation.

Salt tectonics

The presence of Zechstein salt is greatly influenced by the post-Permian structural and sedimentary development of the area. The 3D model allows us to:

- Assess the distribution of Zechstein salt thickness and its relation to salt flow;
- Map the salt deformation styles (ridges, pillows, lateral intrusions) in relation with fault styles and orientations;
- Map the regional outlines of the timing of salt deformation phases using back-stripping analysis.

3D-Subsurface mapping of the Netherlands

For information on Exploration and Production issues and E&P data see the Netherlands Oil and Gas Portal www.nlog.nl & www.ebn.nl

Interpreted E-W seismic section in the Dutch offshore. Back-stripping analysis corroborates that peak salt flow occurred during Jurassic rifting (204 - 140 Ma) and Late Cretaceous-Tertiary inversion (80 - 20 Ma) of the Central Graben and resulted in the formation of large salt diapirs, rimsynclines and multiple internal unconformities.

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Time-to-depth conversion

The compiled time horizons and faults are converted to depth using a regional velocity model consisting of 10 layers. Except for the layer of the Zechstein Group, which contains multiple salt levels, it is assumed that for each layer velocities increase linearly with depth under the influence of compaction: $V(x,y,z) = V_0(x,y) + k \cdot Z$

The regional compaction coefficient $k$ is determined from the linear least squares relation between the interval velocity ($V_{int}$) and mid-depth ($Z_{mid}$) at boreholes. The location dependent parameter $V_0(x,y)$ is determined at borehole locations and interpolated, using a kriging method, to grids. An example of a gridded $V_0$ map is given in figure on the left. Major variations in the distribution of $V_0(x,y)$ values often coincide with regions of structural inversion (relatively high velocities) and regions where overpressured conditions are present within layers (relatively low velocities). For the Zechstein Group a grid of interval velocities was used.

Uncertainty assessment

The modeling workflow includes an assessment of uncertainties of depth and thickness of the stratigraphic layers. Errors can be introduced by the following processes:

- Interpolation of interpretations,
- Velocity model used for T-D conversion,
- Number of wells,
- Distance to well