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Modelling the Dutch subsurface: From paper product towards dissemination of a 3D-digital model

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The Netherlands can be considered a country with a long history of exploration for various subsurface resources such as coal, hydrocarbons and salt. Today, new resources and functions of the subsurface, such as unconventional hydrocarbon resources, geothermal energy potential and storage of natural gas, oil, and CO2, water management and nuclear waste storage cause increasing demand for assimilating knowledge of the deep subsurface.

Since the mid nineteen eighties, the Geological Survey of the Netherlands (TNO-GDN) has been commissioned to compile a consistent, regional-scale petroleum geological framework for the deep subsurface of the Netherlands, both on- and offshore. Due to the new mining law issued in 2003, this effort has been boosted by large quantities of E&P well- and 3D-seismic data becoming publicly available. By using an ever-increasing amount of the subsurface data, the modelling workflow has led to a much more detailed set of mapping products, including maps, grids, stratigraphic charts, specialised studies and more recently a 3D-model: the Digital Geological Model-deep (DGM-deep).

For matters of constructing, quality-checking and updating these products, TNO-GDN set up a novel workflow (*Figure **1***). The improvement of data quality and -coverage did not only result in better models, but also allow more sophisticated and fully data-driven techniques for time-depth conversion, fault modelling, property modelling and various offshoot applications that all contributed to our significantly increased understanding of the subsurface. Especially the mapping and modelling of over 3500 faults has significantly increased the quality of the 3D geological model.

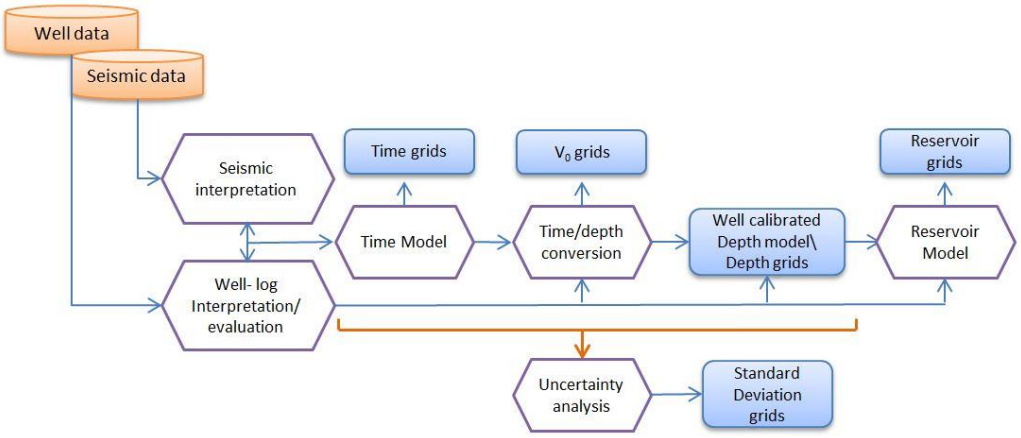

Figure 1: Flow chart of the modelling workflow. Blue shaded boxes indicate the released model output.

The present-day plethora of subsurface applications calls for a new policy for underground spatial planning that is currently being prepared by the Dutch government and which is importantly underbuilt

by GDN's mapping products. For these applications, quantification of uncertainties of the geological models is paramount, although its implementation is not straightforward. For the DGM Deep model a method has been developed to assess uncertainty by combining precision (giving information on the reproducibility of the model results) and accuracy (reflecting the proximity of estimates to the true value). The uncertainty workflow proves to be an effective way to (graphically) represent the reliability of the DGM Deep model.