AUTOMATED WORKFLOWS FOR THE INTEGRATION OF REGIONAL 3D-GEOLOGICAL MODELS

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CONTEXT
By order of ‘Flemish Planning Bureau for the Environment and Spatial Development’

- **G3Dv2-model** (2013): first 3D geological model of Flanders
- **G3Dv3-model** (2019): Updated & refined 3D geological model of Flanders
- **H3D-model** (2019): G3Dv3-model translated into hydrogeological model for Flanders and adjacent areas

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**Goals 2013 – 2018:**

- **Detailed models** for subsurface applications
- **Faults in 3D** (SKUA-GOCAD)
- **Linking** geological and hydrogeological units/models
- Large existing **seismic dataset**
- **Parametrization** of near-surface resources (voxel models)
- **Cross-boundary** harmonization of models (H3O-projects)
- **Integration** existing and new models into **comprehensive models**
- **Integration in DOV**
2013 - 2018

**New models**

- Voxel models of resources (2015 & 2017)

**Existing models**

- G3Dv2
- HCOV

**Integration & automatization**

- 3D Faults
- Modifying, updating & refining previous models

**DOV database**

**G3Dv3 + H3D models**
- New 3D (hydro)geological models of Flanders (Palaeozoic to Quaternary):
  - 117 geological layers
  - 139 hydrological layers

- Output for each layer:
  - 100 x 100 m raster files of top, base, thickness
  - Shapefiles of geological occurrences, fault intersections, isolines

> 1500 maps needed to be produced
AUTOMATED WORKFLOW
MODELLING TASKS

- **Combine** input data into standardized formats
- **Convert stratigraphy** (cross-boundary projects, (hydro)geological units)
- **Re-model** input data (if necessary)
- **‘Knit’ raster files** from layers of different projects together across buffer
- **Model detail (new layers)** into existing models
- **Model 3D fault planes** (and extend outside their limits in existing projects)
- **Ensure fault-fault contacts** from different model areas
- **Ensure layer-fault contacts**
- **Ensure overall model consistency** (detect modeling errors)
- **Store the model**
- **Calculate derived products**

  - top, base, thickness
  - borehole sets
  - metadata
  - figures
  - fault traces
  - geographic extent
  - isolines
DATA STORAGE

Layer A
x
y
z

Layer A
polygon

POSTGIS

Fault 1.dxf

Fault 1
polygon

SCRIPT TOOLCHAIN

Interpretations from boreholes, seismics, gravimetrics, mining, geomorphology, previous models,...

Top/ Base/ Thickness maps → Stratigraphy → 3D fault planes → Geological occurrence area → Conversion table

Base of each layer → Fault-corrected base layers → Check layer consistency → Output maps (top/base/thickness/...)

Hydrology maps
- Modeled layers = base or top or thickness
- Stratigraphy = list of stratigraphic position of modeled layers
- Set of logical rules uses stratigraphy to transform input into base layers for each unit
- Each base is stored in db for further use
- In many base layers, faults were vertical ➡️ Needed tilting based on 3D fault planes
- Geological occurrence area to spatially clip base layers

- Layer consistency check used stratigraphic column and thickness calculations to detect errors
- Stratigraphy table + clipped base layers are used to calculate top- and thickness layers for each unit
- Calculated layers are converted to required outputs, e.g.: 100 x 100 m raster maps in generic ASCII format
- Hydrology units can (generally) be derived from geology units
- Use conversion table + simple script to convert names
RESULT

> 20.000 files

34.5 GB of output data
CONCLUSIONS

Lessons learned:
- Include IT from beginning of the project
- Make sure the geo-IT part does not become ‘black box’ for the geologists
- Foresee enough time for QC of the automated results

Advantages:
- Efficiency gain => time saved by automated steps gives more space for geology
- Error reduction (iterative process of model generation)
- Reproducible results
- Structured methodology
- Data consolidation (no more data lost in subfolders or version problems)