COMPILATION AND DISSEMINATION OF A DIGITAL DEEP SUBSURFACE MODEL OF THE NETHERLANDS

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The Subsurface of the Netherlands:
complex geology
rich in resources

Mapping the deep subsurface of the Netherlands

DGM-deep Version	Release digital data	Year of publica-tion	Area	Project	Projection	Velocity model	Fault lines	3D fault planes	Dino *loket*
v1.0	2002	2004	Onshore	GEO-atlas	RD-Bessel 1841	Various	Yes	No	
v2.0	2006	2006	On-Offshore	NCP-1	ED50-UTM31	VELMOD-1	Yes	Yes	
v3.0	2010	2012	Offshore	NCP-2	ED50-UTM31	VELMOD-2	Yes (Sub-regions A-G)	Yes	
v4.0	2014		Onshore		RD-Bessel 1841	VELMOD-3	No	No	Yes

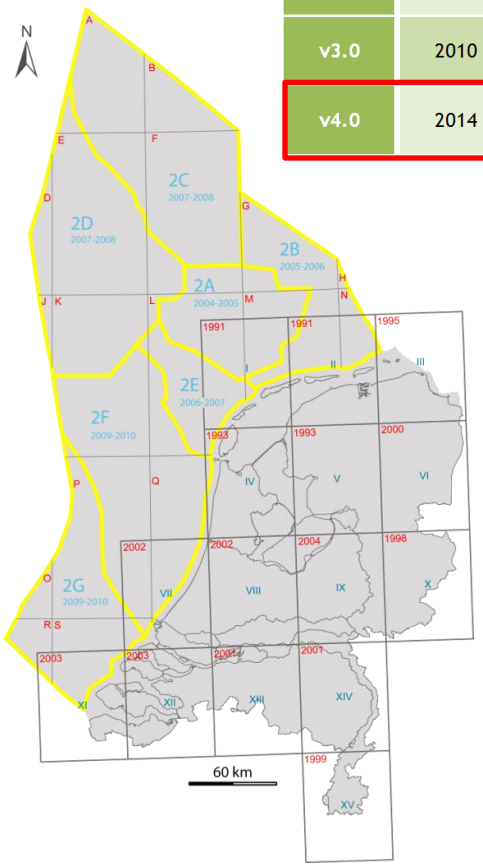
Modelling:

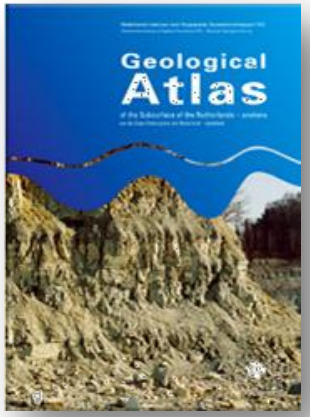
Mainly analogous

Mainly digital

Completely digital

Digital & automated

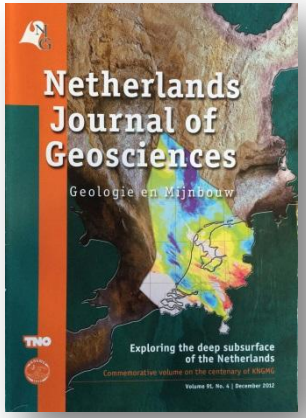




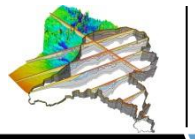
V1.0

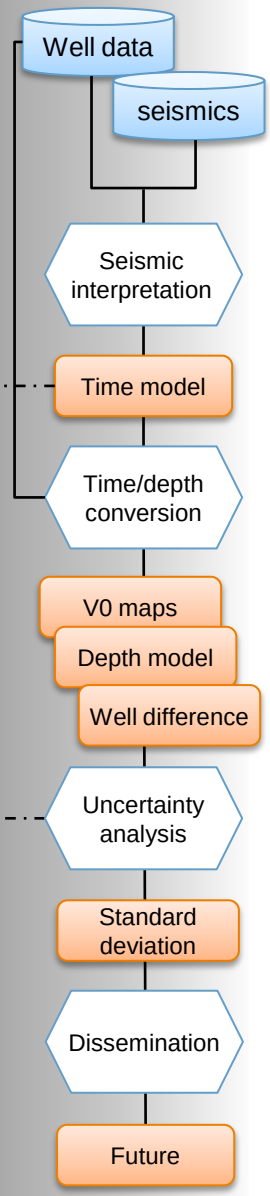
V2.0

Subsurface structure of the Netherlands – results of recent onshore and offshore mapping



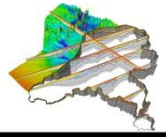
V3.0



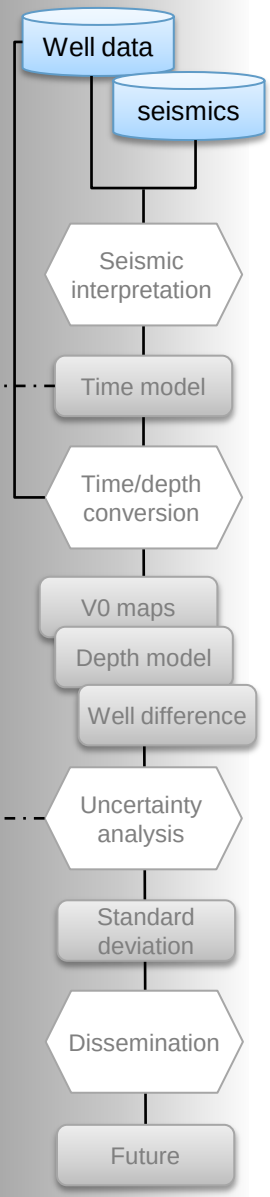


Outline

- DGM-deep workflow
  - Data
  - Methods & Techniques
  - Uncertainty
  - Products
- Dissemination of DGM deep
- Future

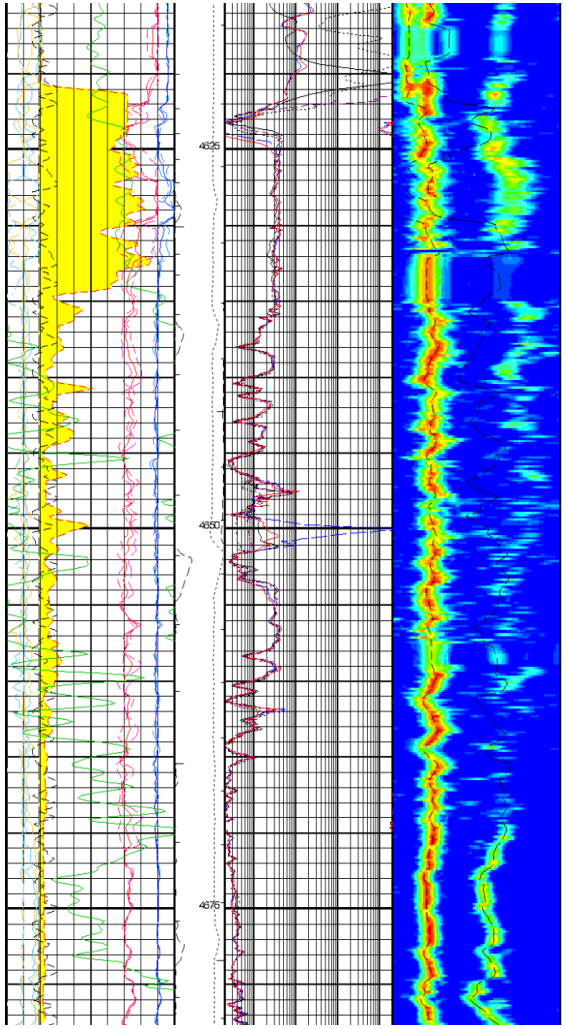


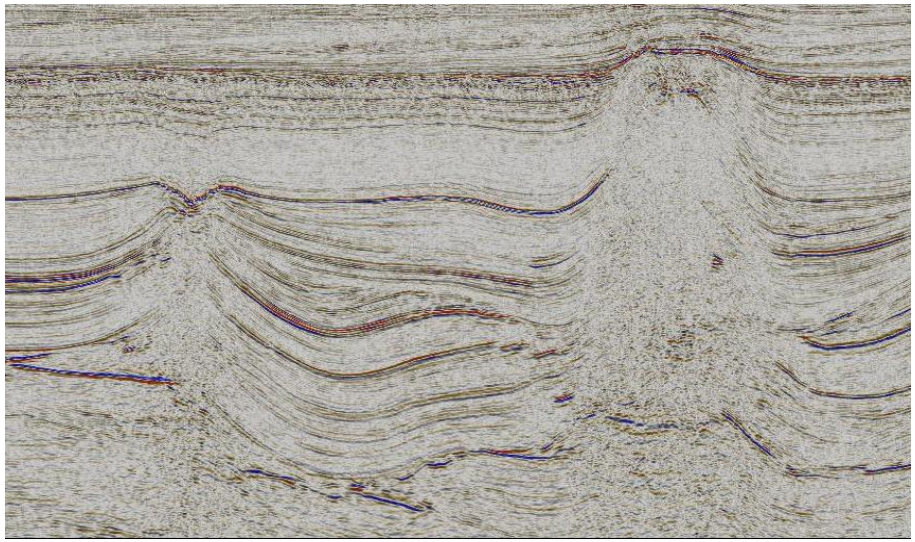
TNO innovation for life

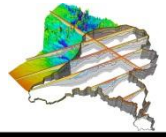


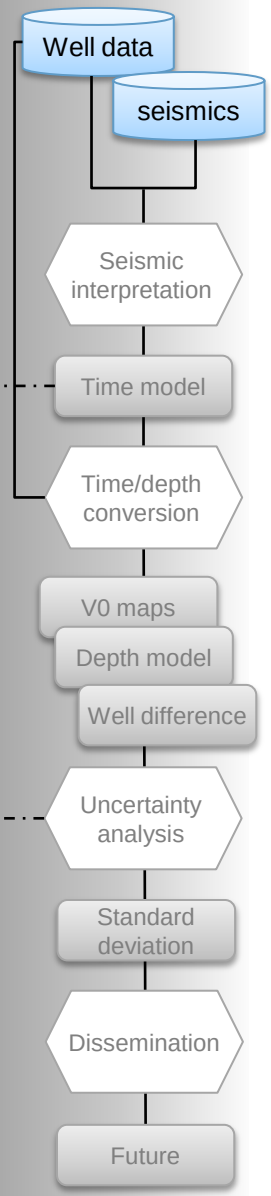
Well data & seismic data

- Cores & well logs (gamma-ray, sonic-, neutron-logs)
- 2D & 3D Seismic data



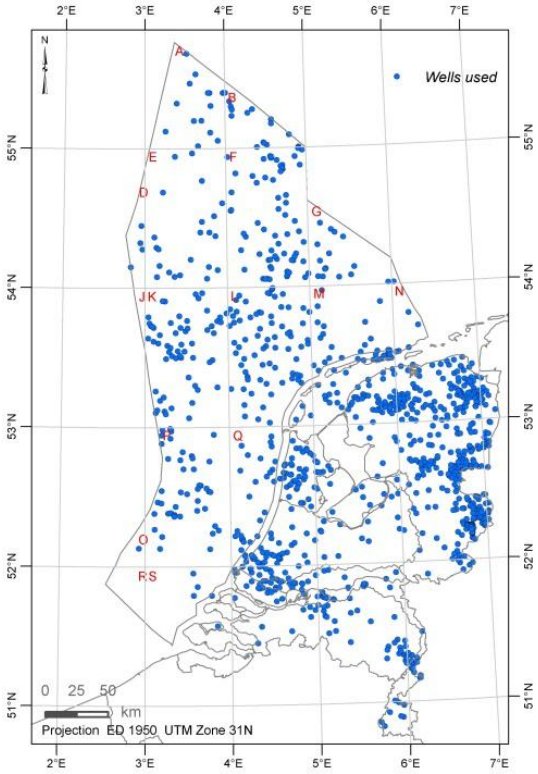


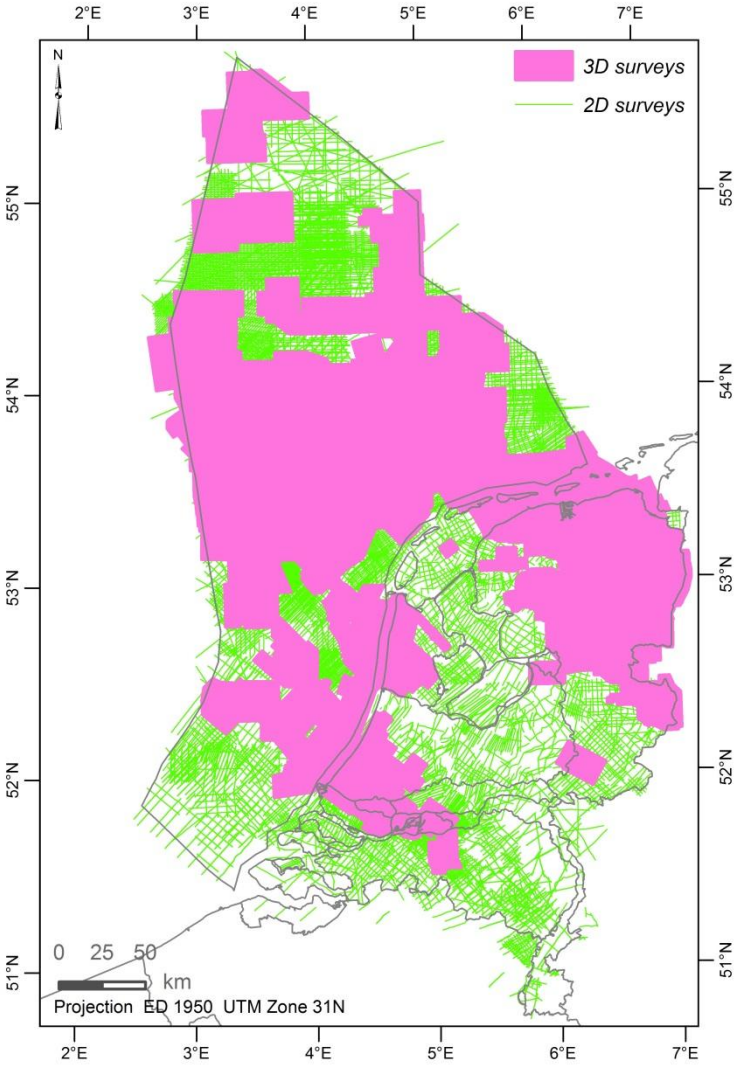


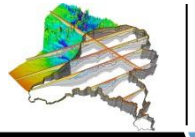


Seimic- and well data coverage

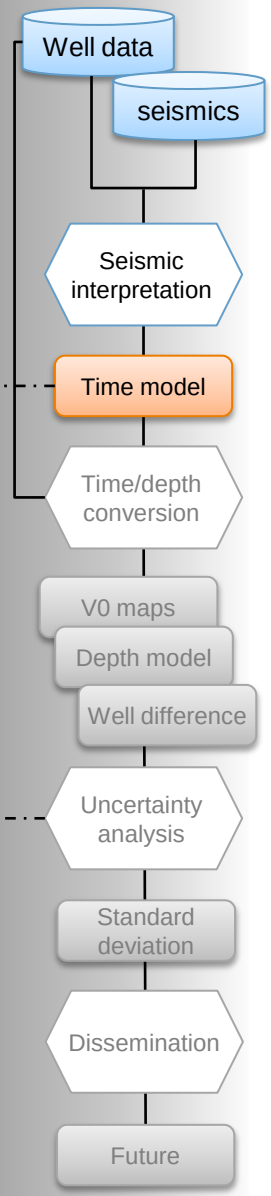
- ~60% coverage 3D seismic data
- 1305 wells used





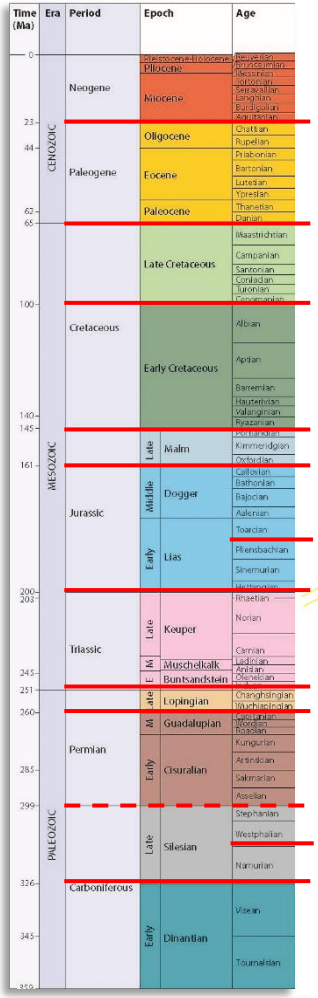


TNO innovation for life



Products

- Main-stratigraphic horizons (250 x 250 m grids)
- Regional model (TWT) - 11 seismic horizons

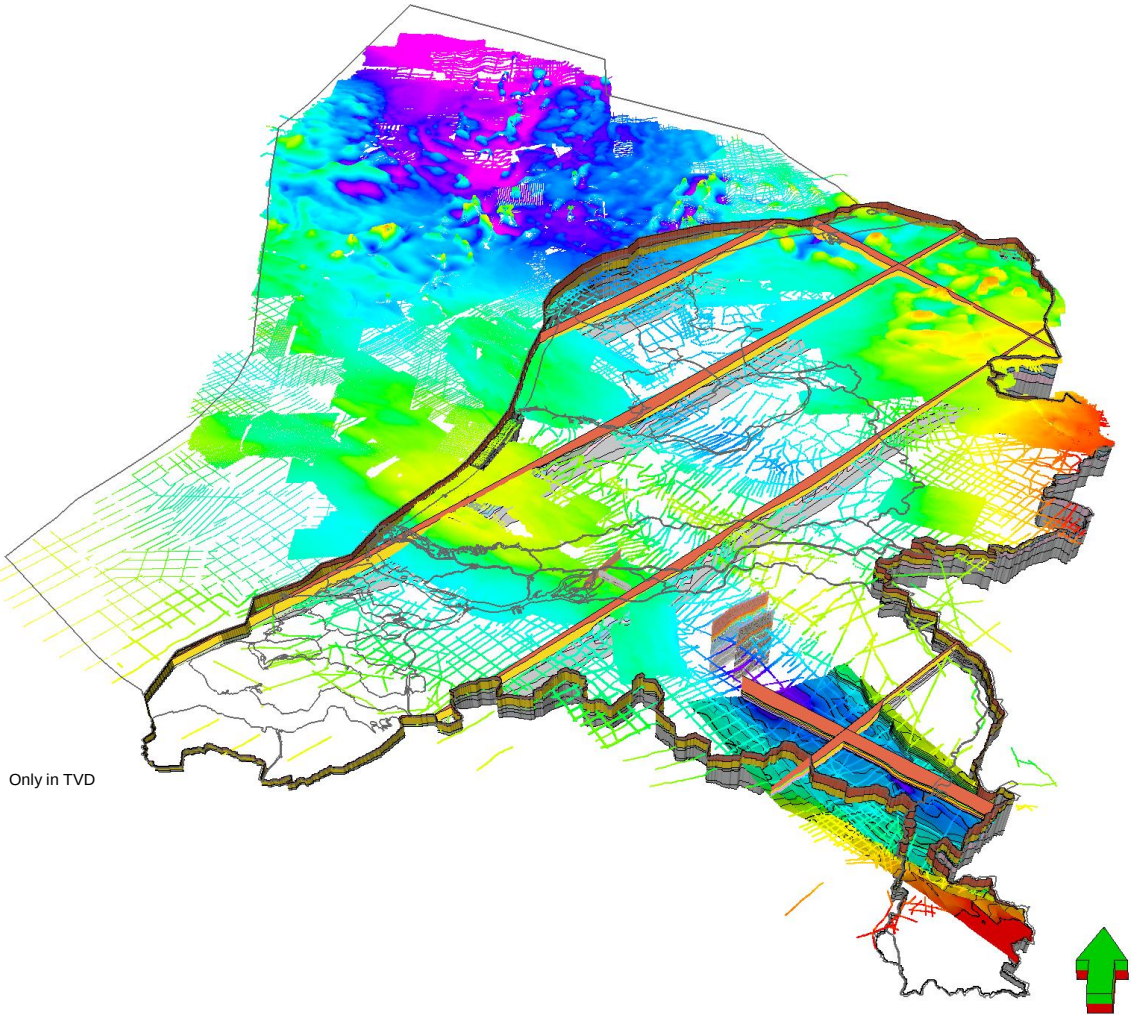


Posidonia Schale Fm.

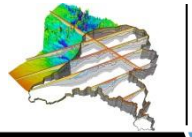
Top Zechstein salt

Base Westphalian

Top Dinantian



Only in TVD



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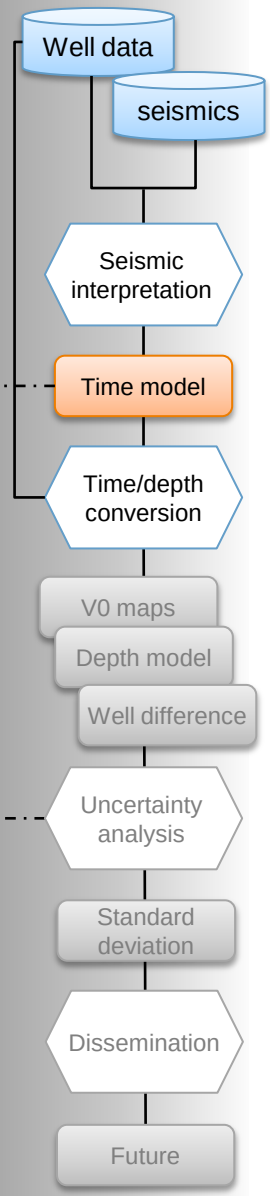
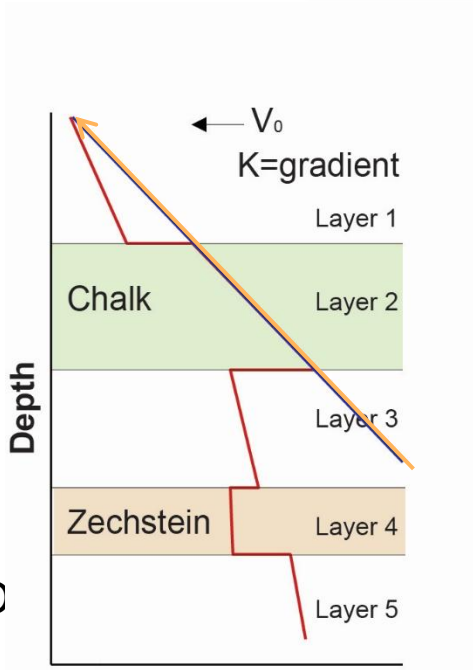
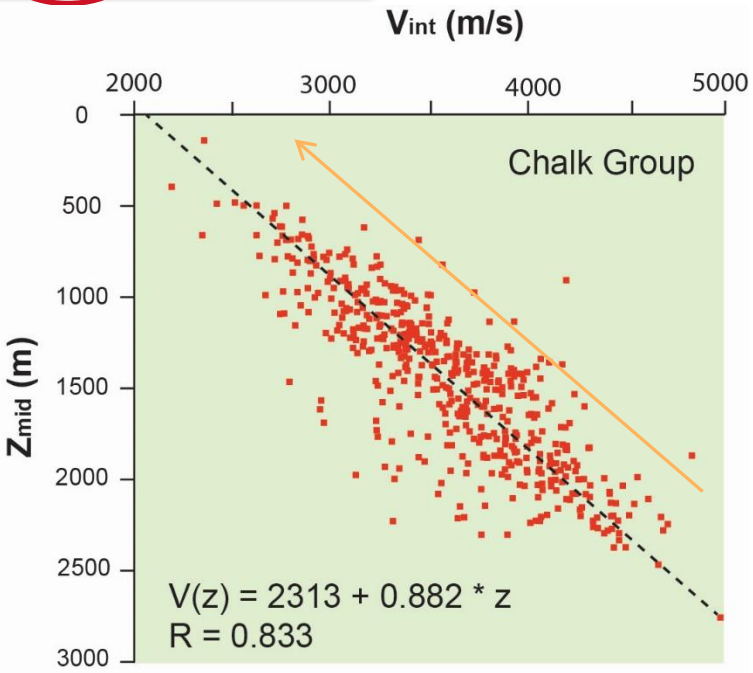


Time - depth conversion – Velmod

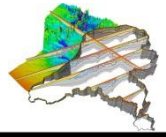
- Velocity data from well logs (sonic, checkshots)
- V_0, k method (V increases linearly under influnce of burial & compaction)
- Interval velocity for Paleozoic Zechstein (salt)

$$V(xyz) = V_0(xy) + K \cdot z$$

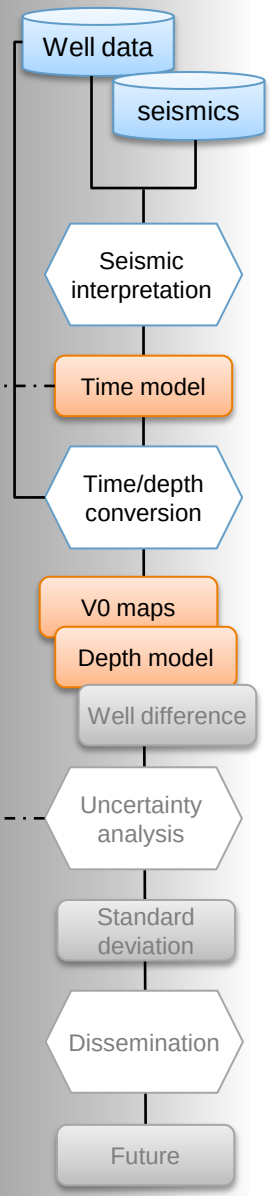




(Van Dalfsen et. al, 2006)



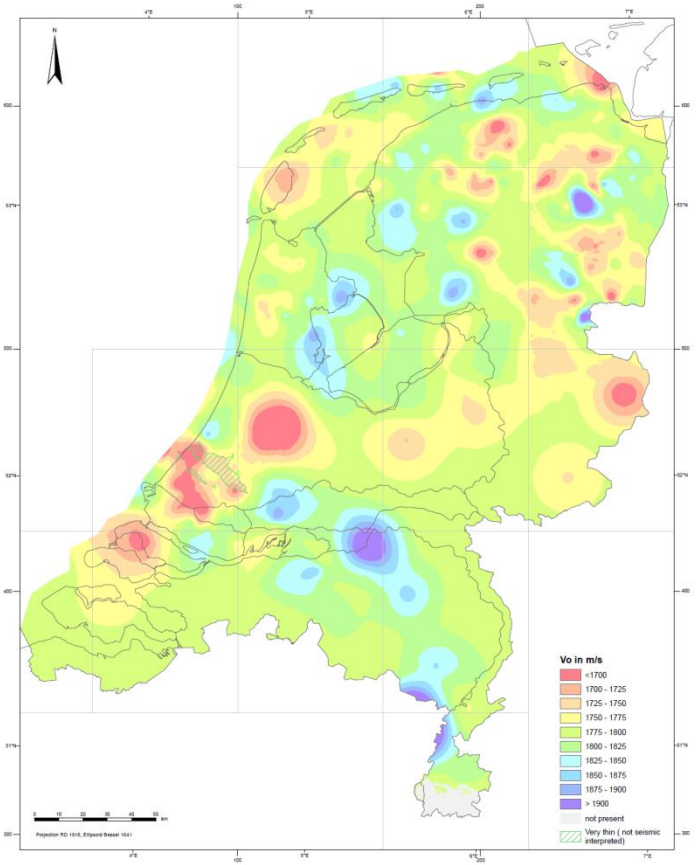
TNO innovation for life



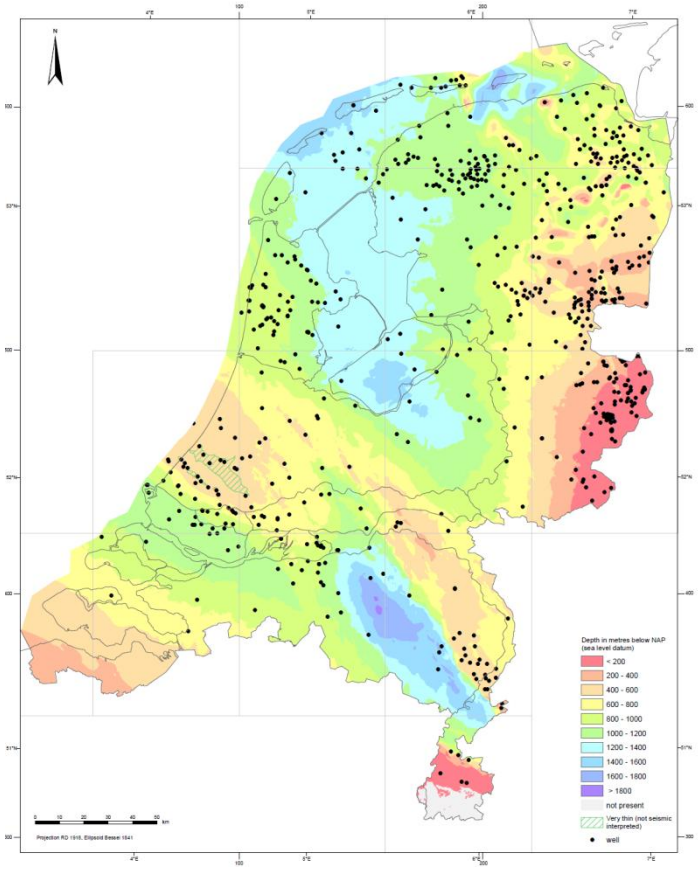
Products

For main stratigraphic horizons (250 x 250m)

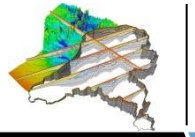
- Velocity (V_0) maps
- Regional subsurface model in TVD (depth)



Velocity (V_0) of the North Sea Supergroup

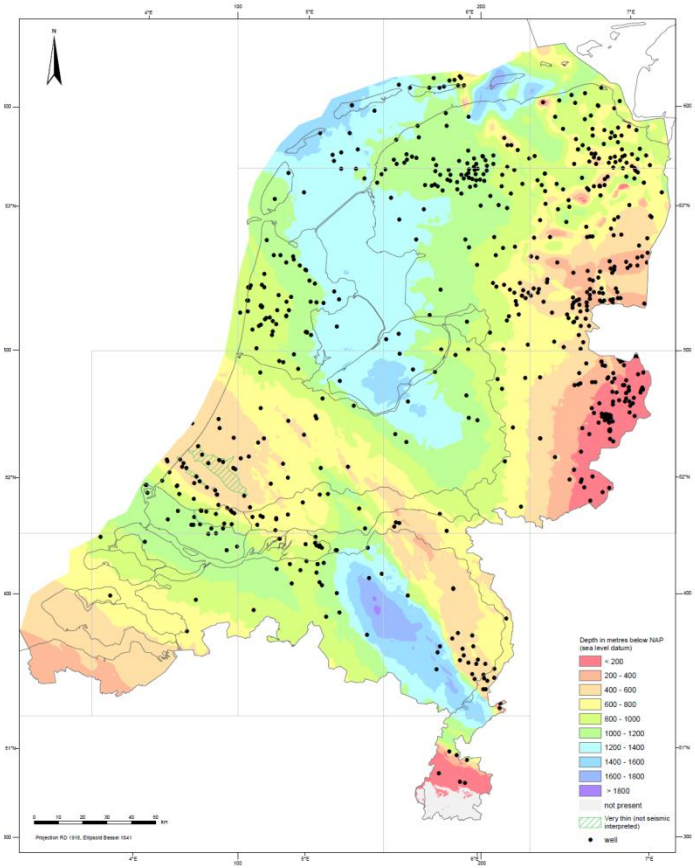


Depth of the North Sea Supergroup

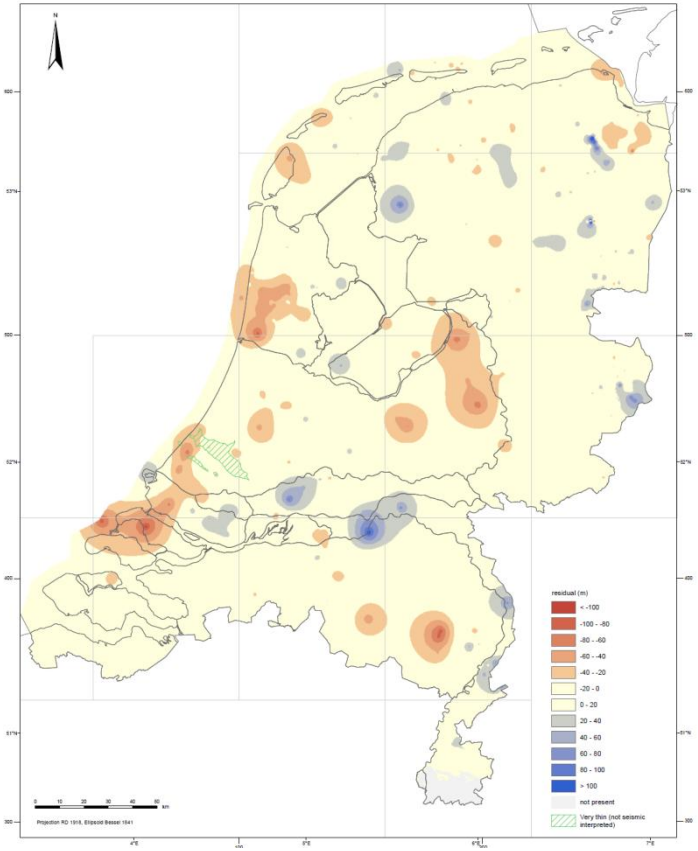


Well difference map

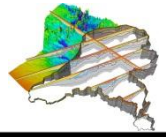
- Misfit between real depth at well location and model depth



Depth of the North Sea Supergroup



Well difference of the North Sea Supergroup



TNO innovation for life

Well data

seismics

Seismic interpretation

Time model

Time/depth conversion

V0 maps

Depth model

Well difference

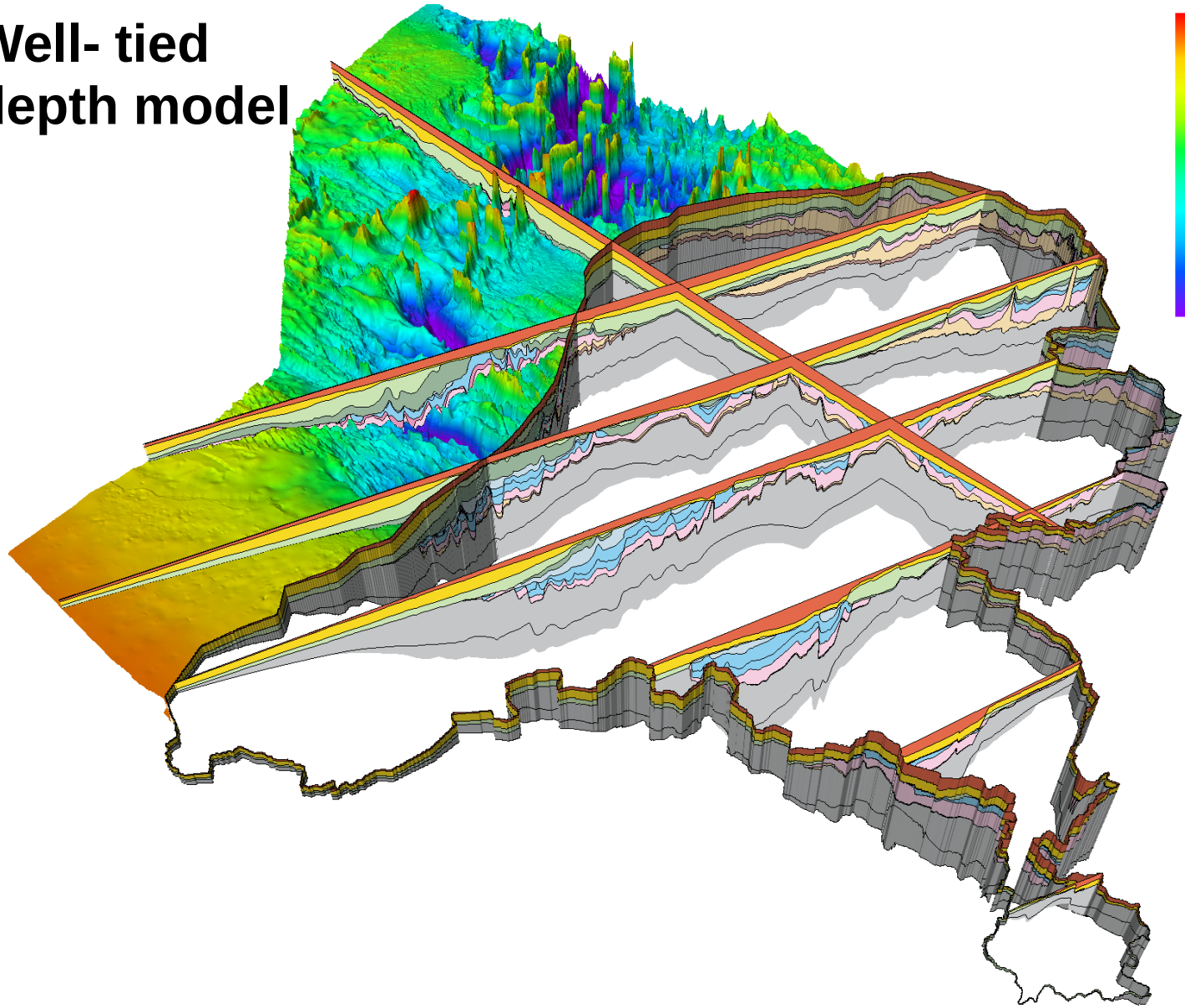
Uncertainty analysis

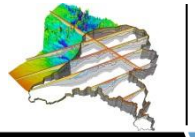
Standard deviation

Dissemination

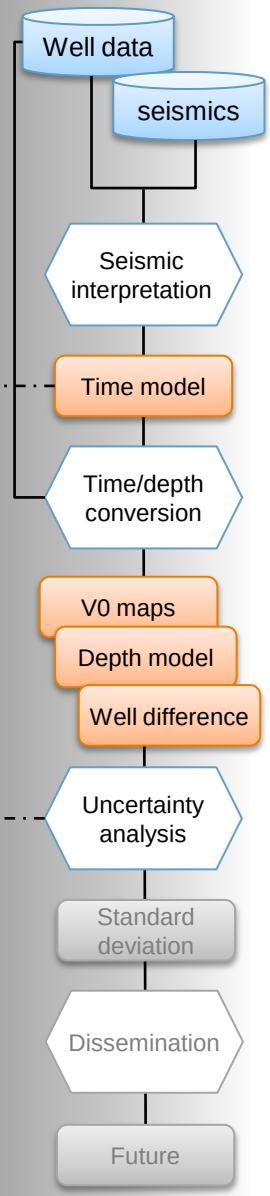
Future

Well- tied depth model



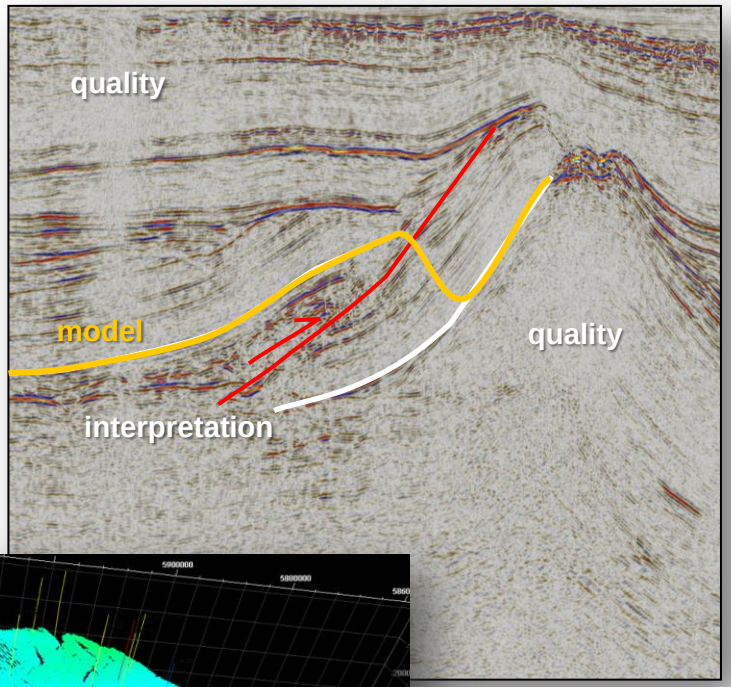


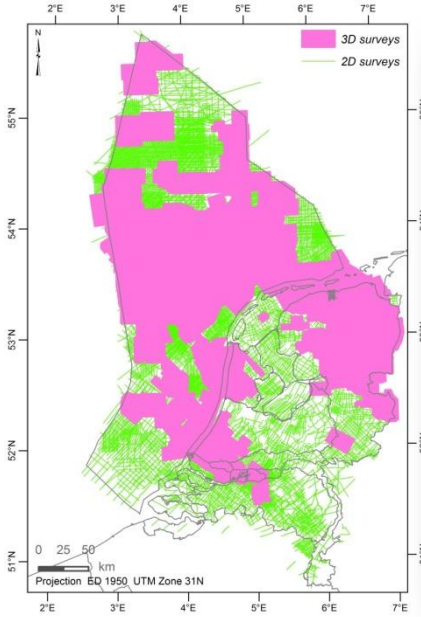
TNO innovation for life

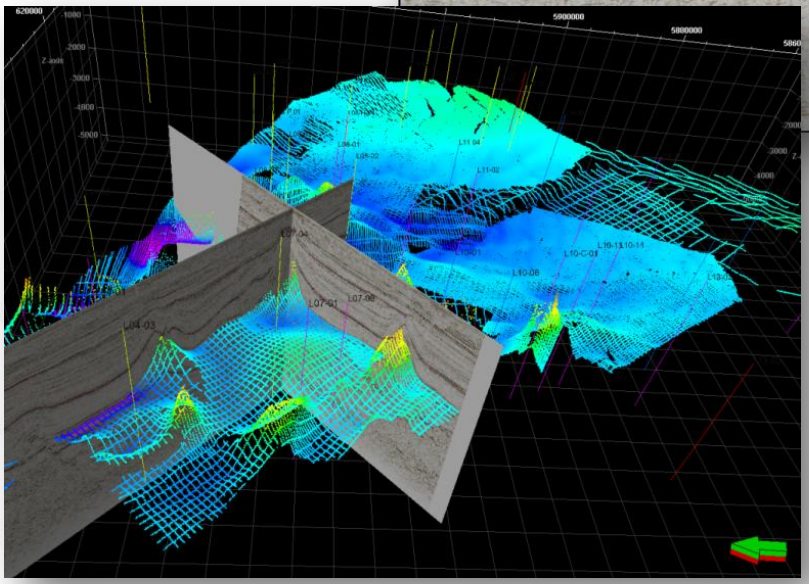


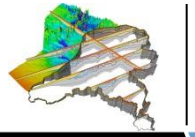
Model uncertainty

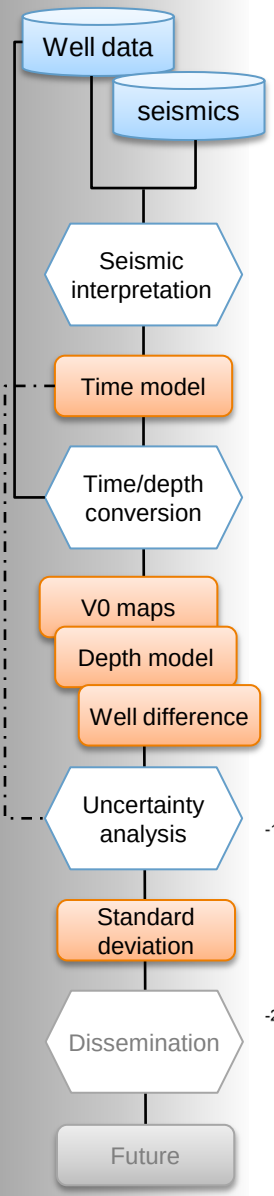
- Precision varies due to data density, -quality en -complexity
- Deviations from reality





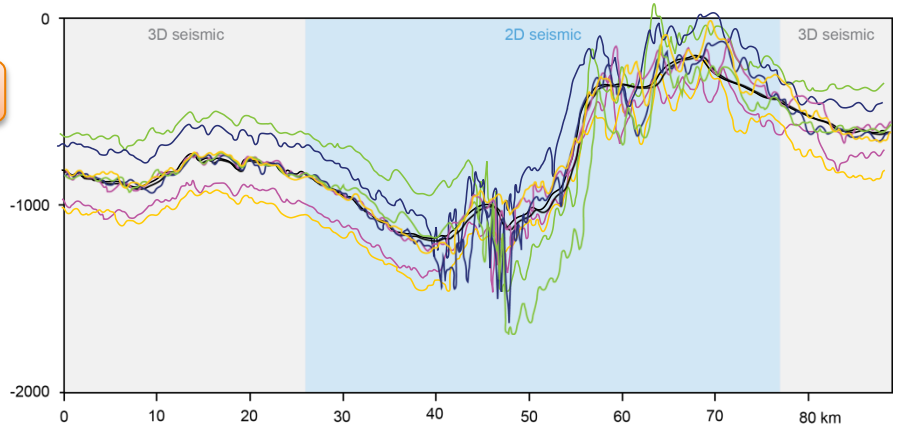


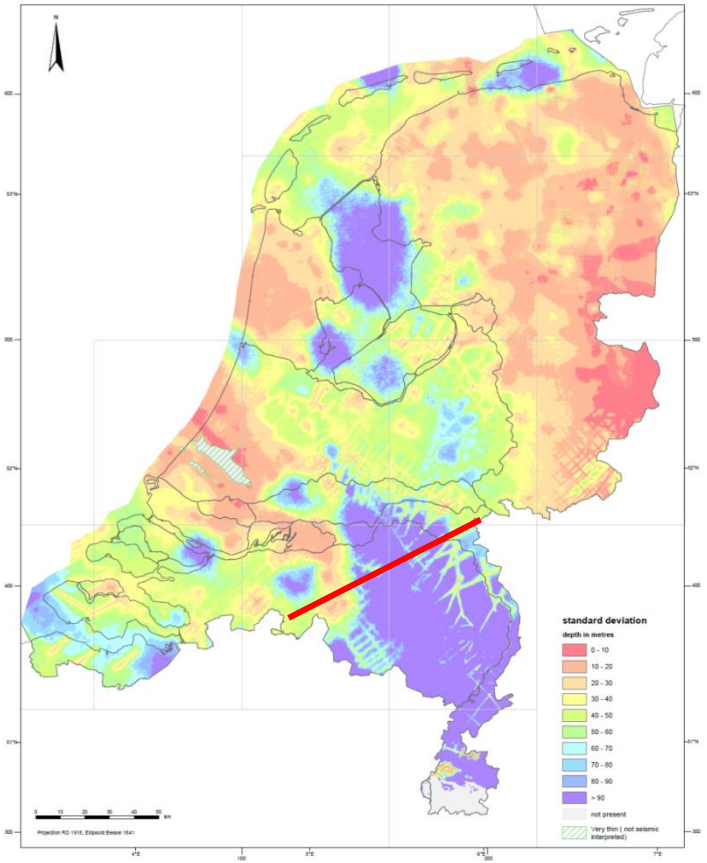




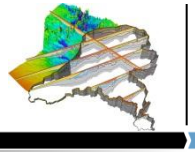
Standaard Deviation

- Stochastic approach
- Multiple realizations of time, velocity, & depth
- Seismic Interpretation, density (2D- or 3D) structural complexity
- Measure for precision

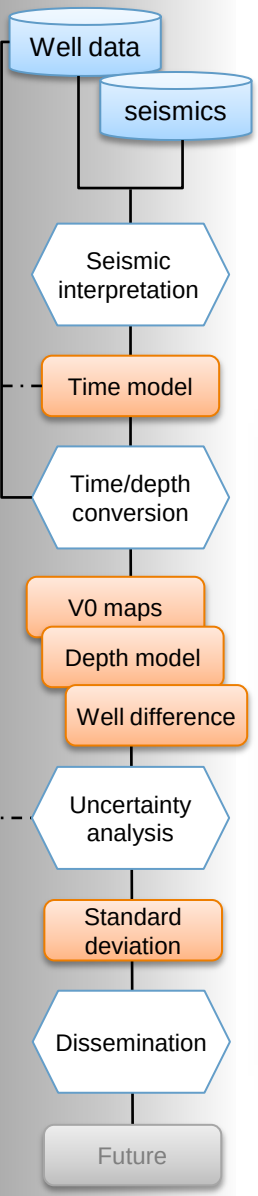




SD of the Noordzee Supergroup (depth)
Blue = high SD; red = low SD



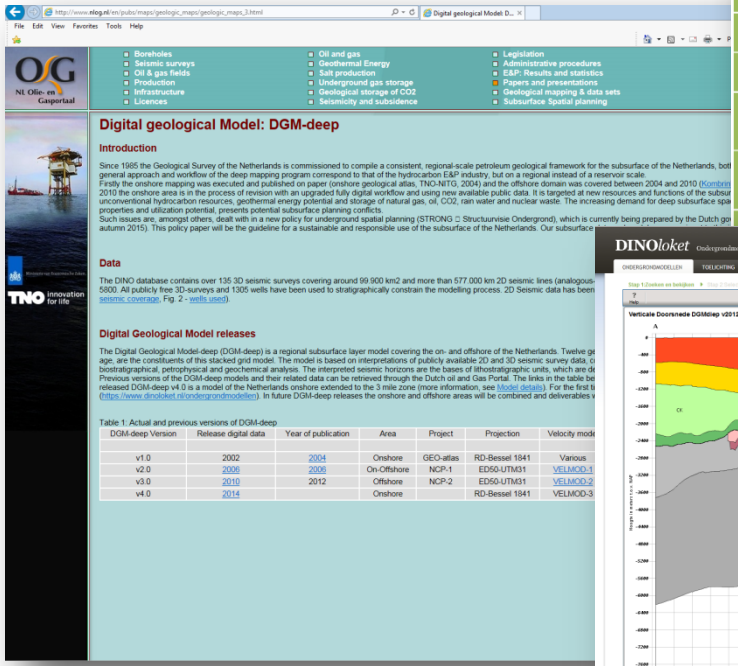
TNO innovation for life

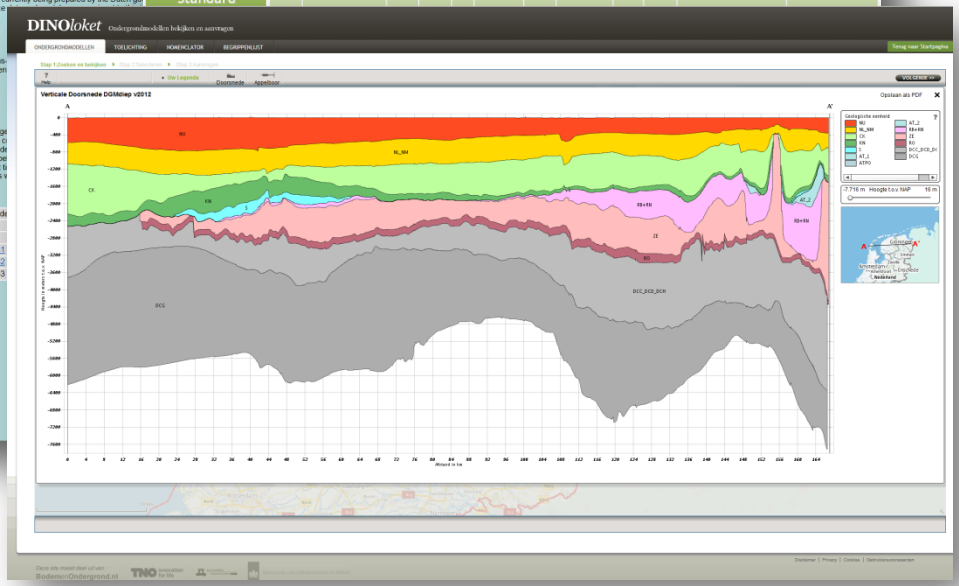


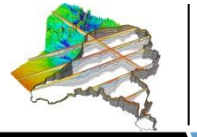
Dissemination of DGM-deep products

- www.nlog.nl
- DINO*loket*

Data type	Stratigrafic unit											
Seismic Interpretation - pointsets (ms)	NU	N	CK	KN	S	ATPO	AT	RB	ZE		DCC	DC
Time (TWT, ms)	NU	N	CK	KN	S	ATPO	AT	RB	ZE		DCC	DC
Time thickness (TWT, ms)		N	CK	KN	S		AT	RB+RN	ZE			DCG
Velocity - V0 (m/s)	NU	NL+NM+NU	CK	KN	S		AT	RB+RN			DC-Overburden	DC-Overburden
Velocity - Vint (m/s)									ZE			
Depth (m)	NU	N	CK	KN	S	ATPO	AT	RB	ZE	RO	DCC	DC
Thickness (m)		NL+NM	CK	KN	S		AT	RB+RN	ZE	RO	DCC+DCD+DCH	DCG
Residual (m)	NU	N	CK	KN	S	ATPO	AT	RB	ZE		DCC	DC
Standard deviation - TWT (ms)	NU	N	CK	KN	S	ATPO	AT	RB				
Standard deviation - V0 (m/s)	NU	NL+NM+NU	CK	KN	S		AT	RB+RN				
Standard												

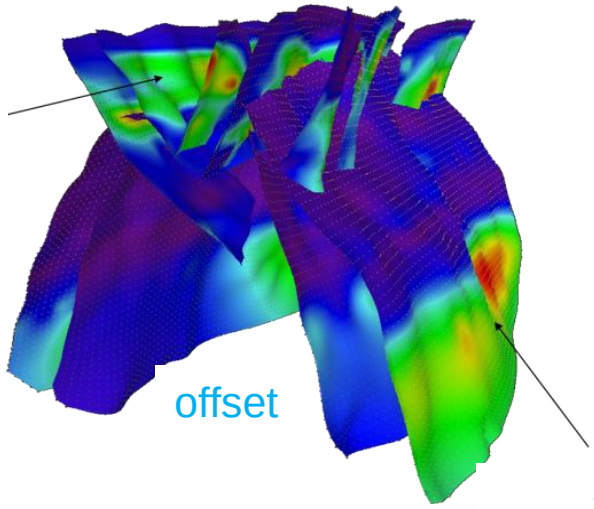


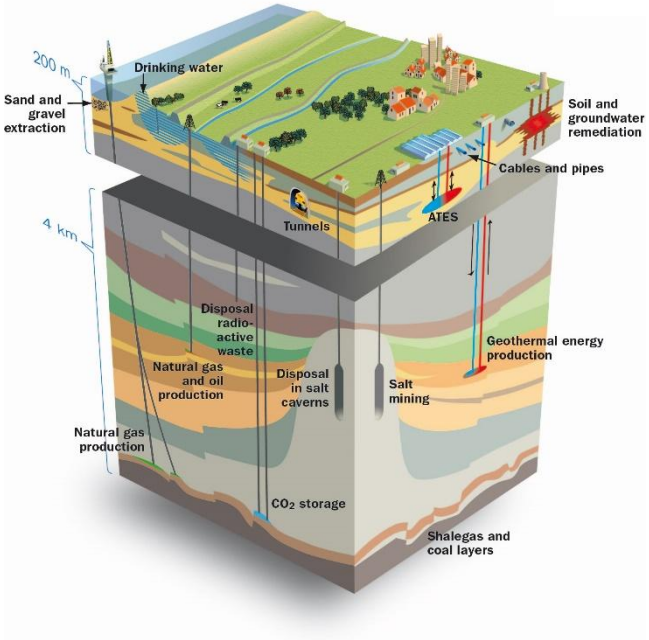




Future

- Faults
  - 3D surfaces
  - Database
  - Faultproperties
- Specific applications
  - Cross border hydrogeological model
  - “Breuken beleven”
  - Aquifers and aquitards
    - *O&G exploration*
    - *Storage*
    - *Geothermal energy*
  - Geomodel North Netherlands
    - *Faults*
    - *Rock properties*






Thank you for your attention
Photo: J.J. Gerrits

Software used:

<u>Petrel (Schlumberger):</u>

Seismic interpretation (horizons, faults)
Well log interpretation and correlation
Horizon modeling
Time – Depth conversion
Fault modelling

<u>Jewel Suite (JOA):</u>

Fault modeling

<u>Isatis (Geovariances):</u>

Uncertainty modeling (stochastic)

<u>ArcGis (Esri):</u>

Dissemination
Mapping

<u>Automation:</u>

Python
PostgreSQL + PostGIS