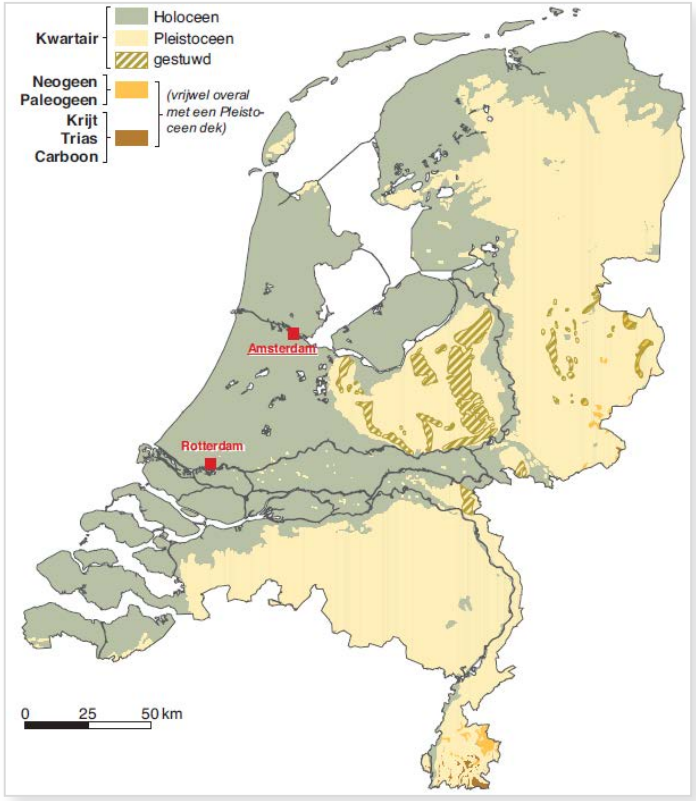
PROGRESS IN GEOMODELLING AT TNO

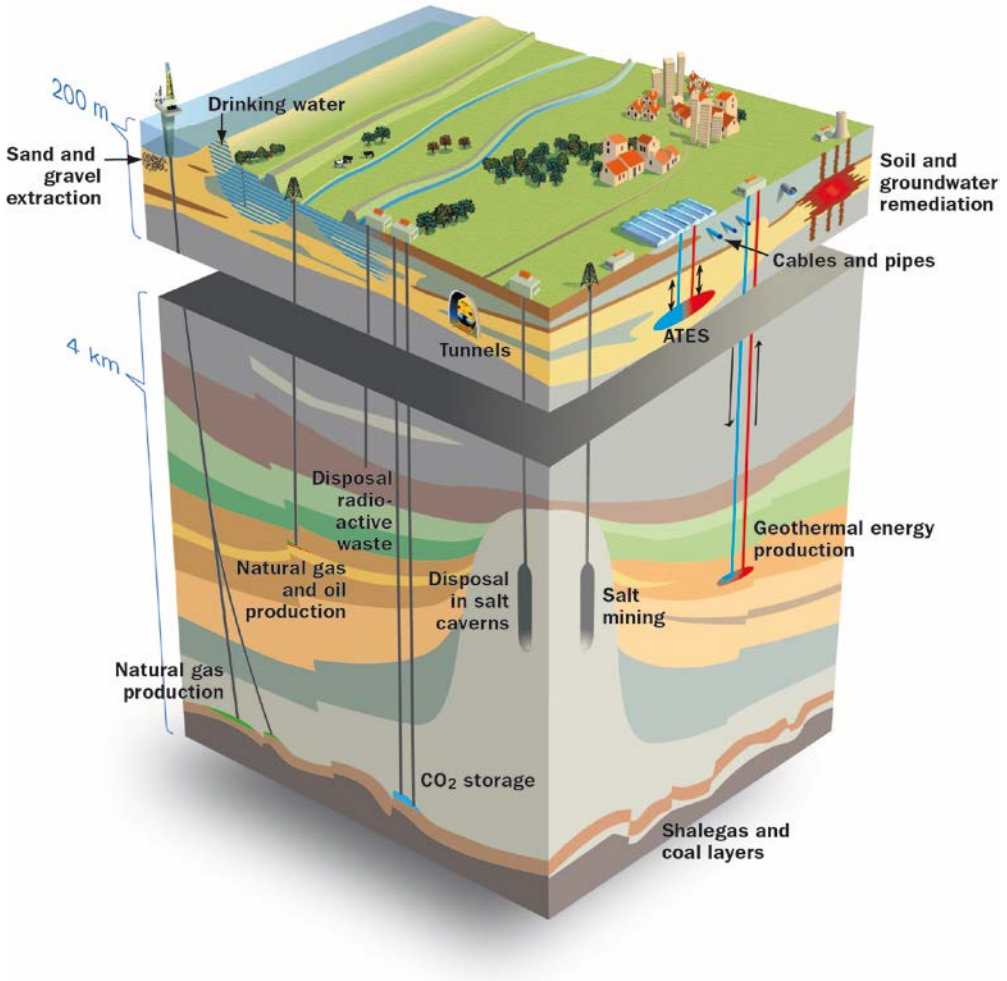
Michiel van der Meulen

TNO innovation for life

INTRODUCTION

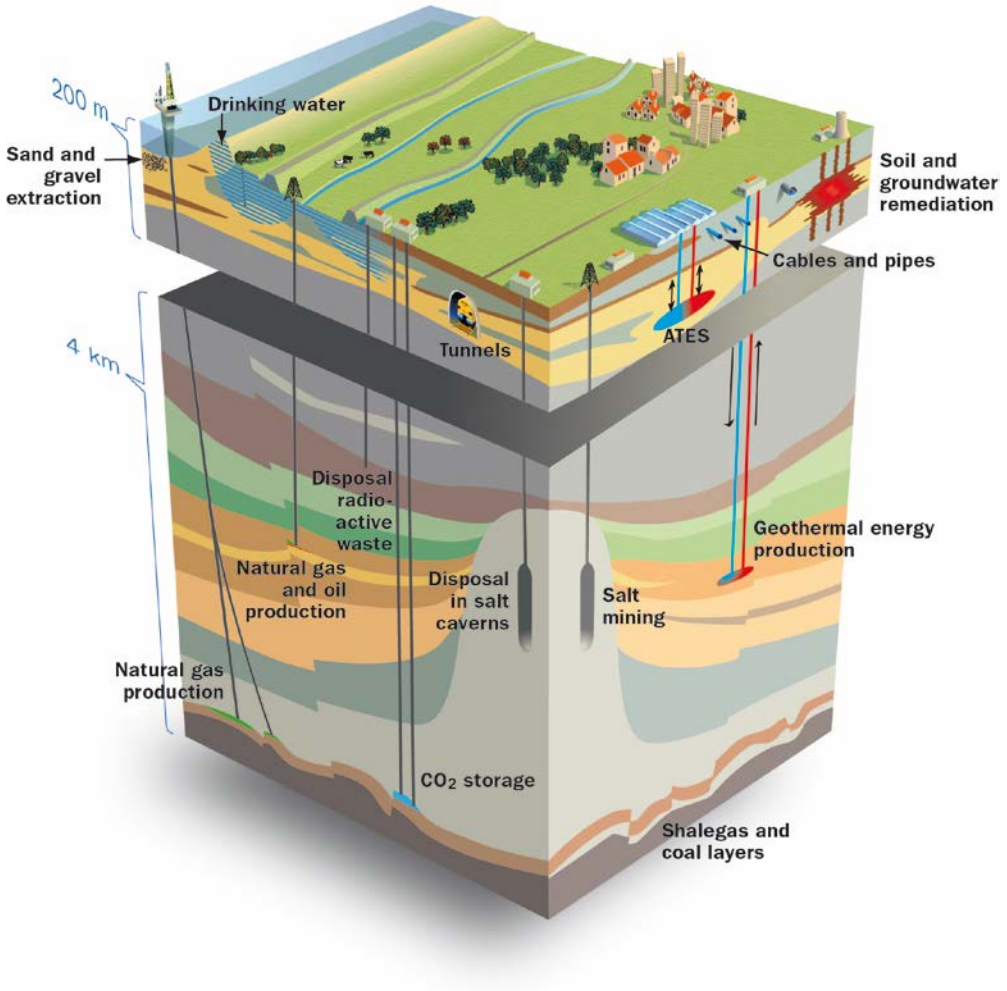
- introduction to our work
- progress?
  - by areal extent
  - quality — DBP
  - uncertainty — Demo
  - dissemination


Kwartair
Holoceen
Pleistoceen
gestuwd
Neogeen
Paleogeen
Krijt
Trias
Carboon
(vrijwel overal met een Pleistoceen dek)
Amsterdam
Rotterdam
0 25 50 km


200 m
Drinking water
Sand and gravel extraction
Soil and groundwater remediation
Cables and pipes
ATES
Tunnels
4 km
Disposal radio-active waste
Natural gas and oil production
Disposal in salt caverns
Salt mining
Geothermal energy production
Natural gas production
CO_2 storage
Shalegas and coal layers

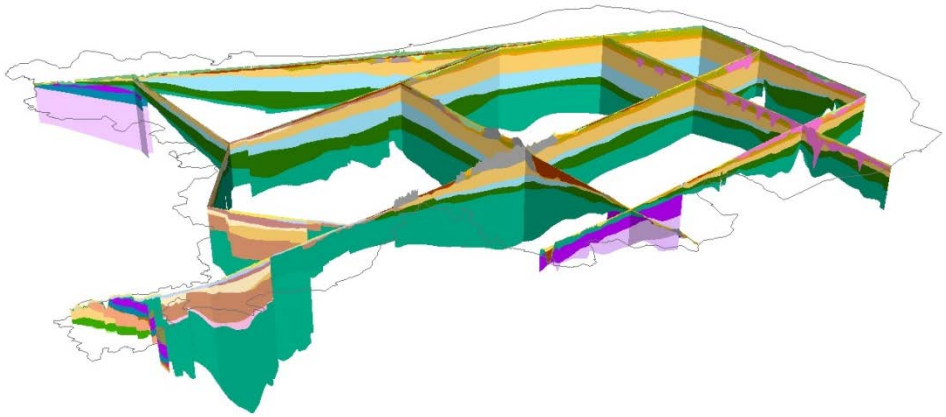
GEOMODELLING AT GDN

- four models
  - nationwide
  - produced systematically
- disseminated via internet portal



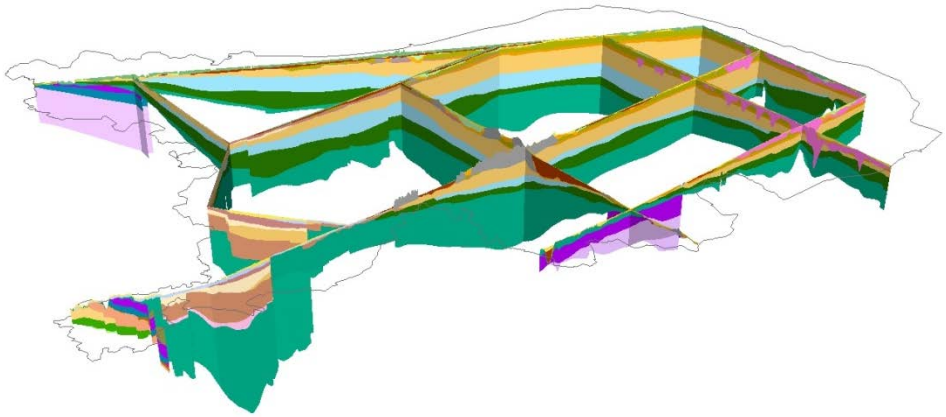
FOUR MODELS

- **DGM-deep**
  - model type — layer model (seismostratigraphic units)
  - areal extent — Netherlands, including Dutch sector of North Sea
  - depth range — several kilometers
  - application — mainly energy
  - data used — seismic + deep boreholes
  - investment — ~800 k€/a
  - since — mid 1980s



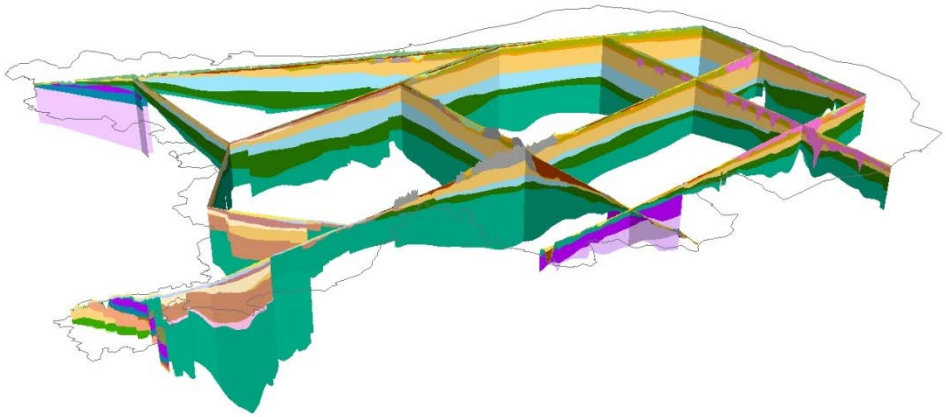
FOUR MODELS

- **DGM**
  - model type — layer model (lithostratigraphic units)
  - areal extent — Netherlands (onshore only)
  - depth range — several hundreds of meters
  - application — mainly groundwater, production of REGIS-II
  - data used — 16,500 boreholes
  - investment — ~800 k€/a (including REGIS-II)
  - since — late 1990s



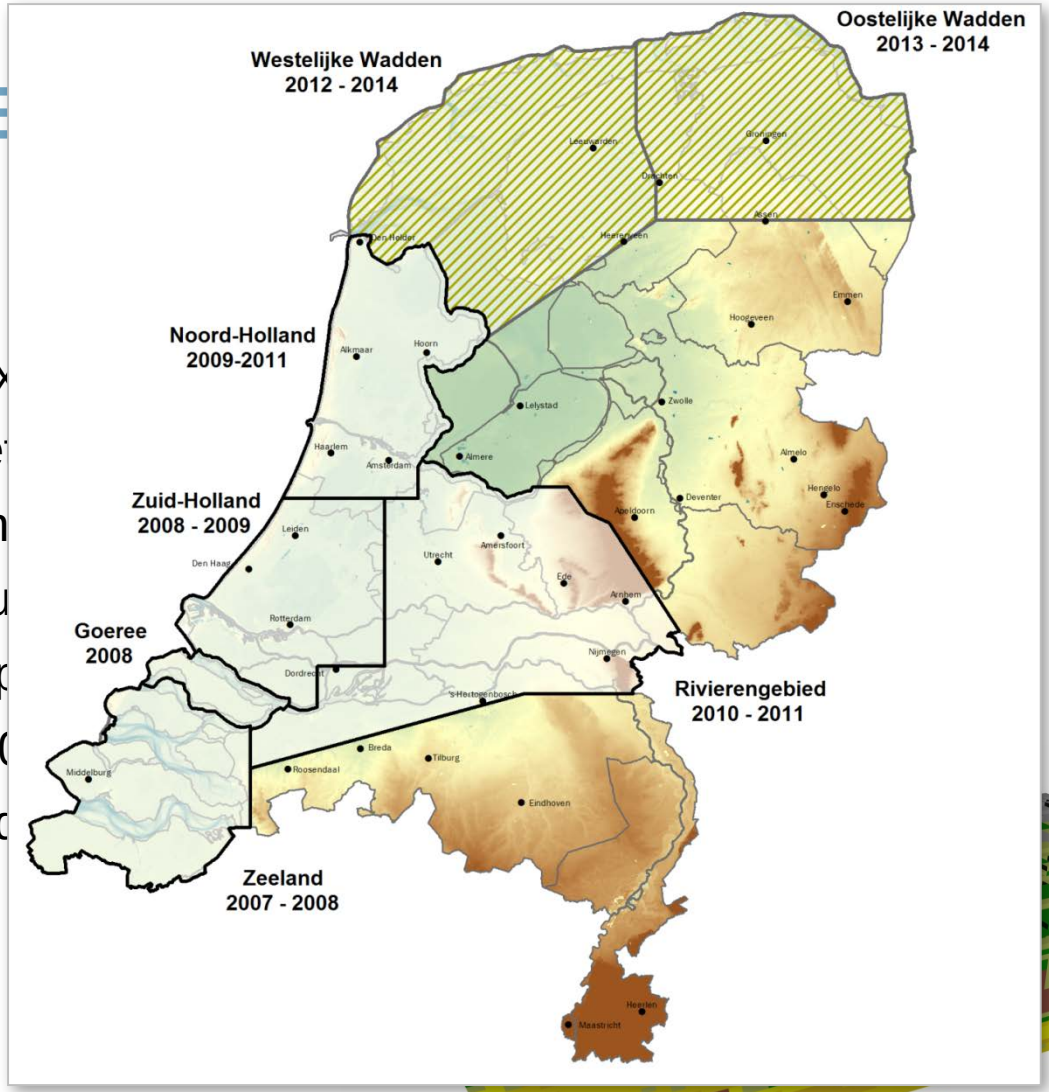
FOUR MODELS

- **REGIS-II**
  - model type — layer model (hydrostratigraphic units + hydraulic parameters)
  - areal extent — Netherlands (onshore only)
  - depth range — several hundreds of meters
  - application — groundwater
  - data used — 16,500 boreholes, same as DGM
  - investment — ~800 k€/a (including REGIS-II)
  - since — early 1990s



FOUR MODE

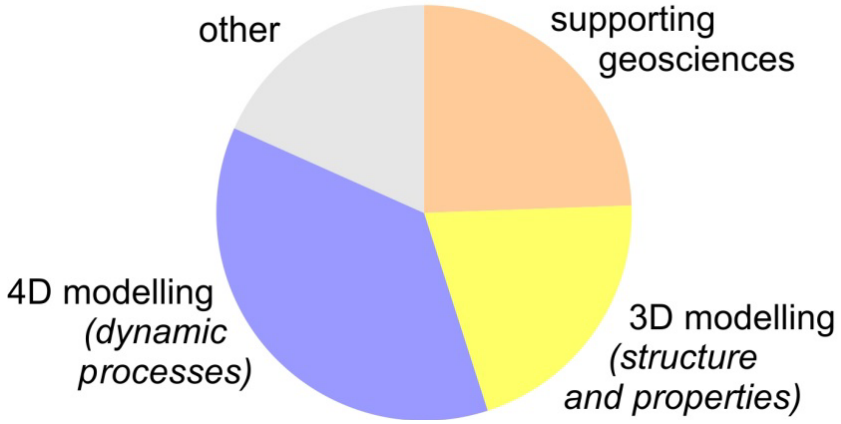
- **GeoTOP**
  - model type vox
  - areal extent Ne
  - depth range ten
  - application (bu
  - data used in p
  - investment ~70
  - since mid

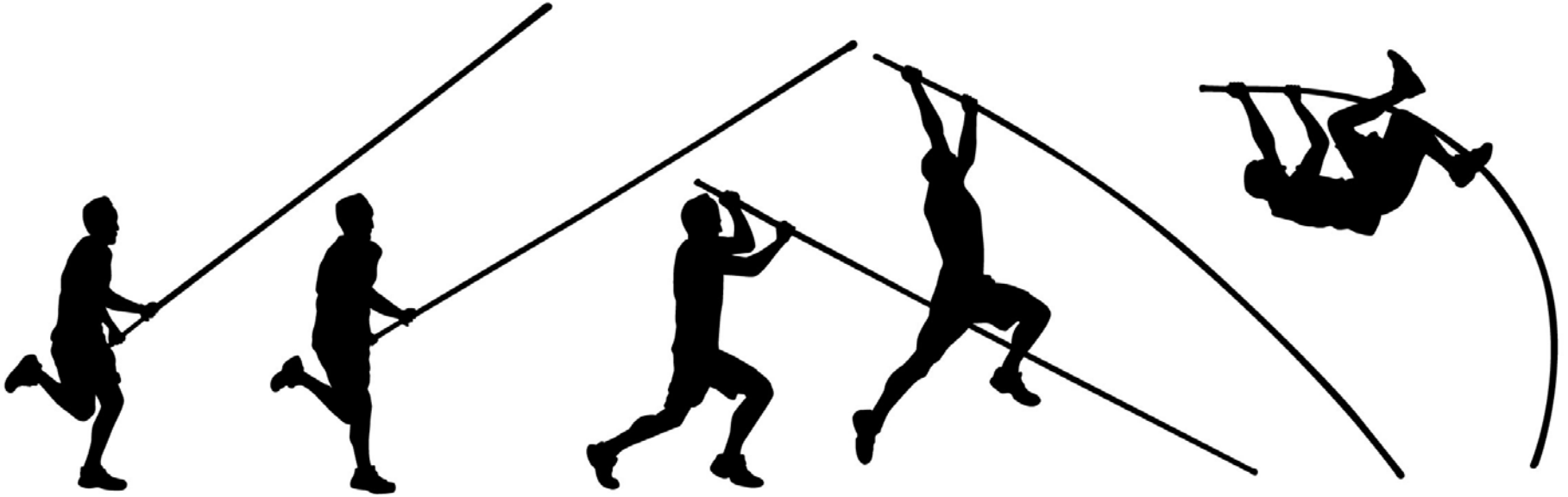


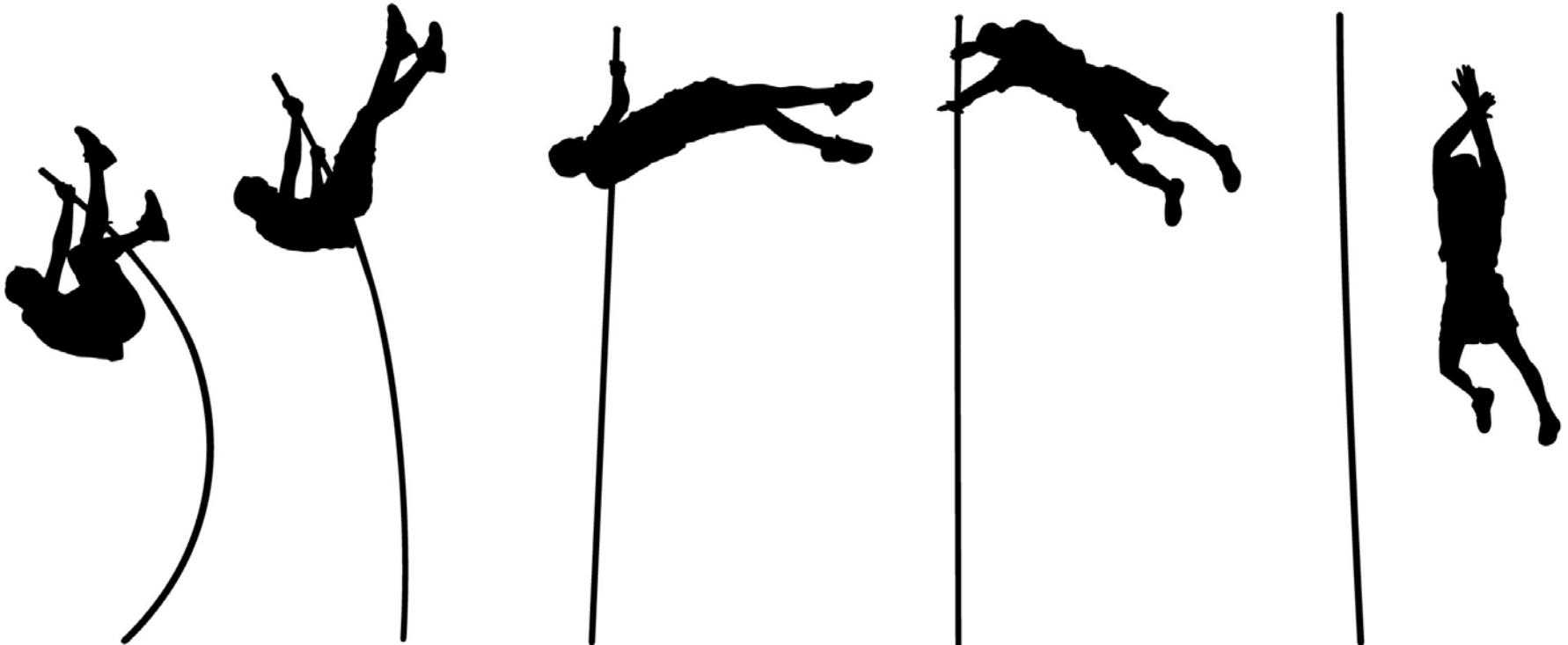
RESEARCH FOR GEOMODELLING

- supporting geosciences
- 3D modelling: structure and properties of the subsurface
- 4D modelling: processes

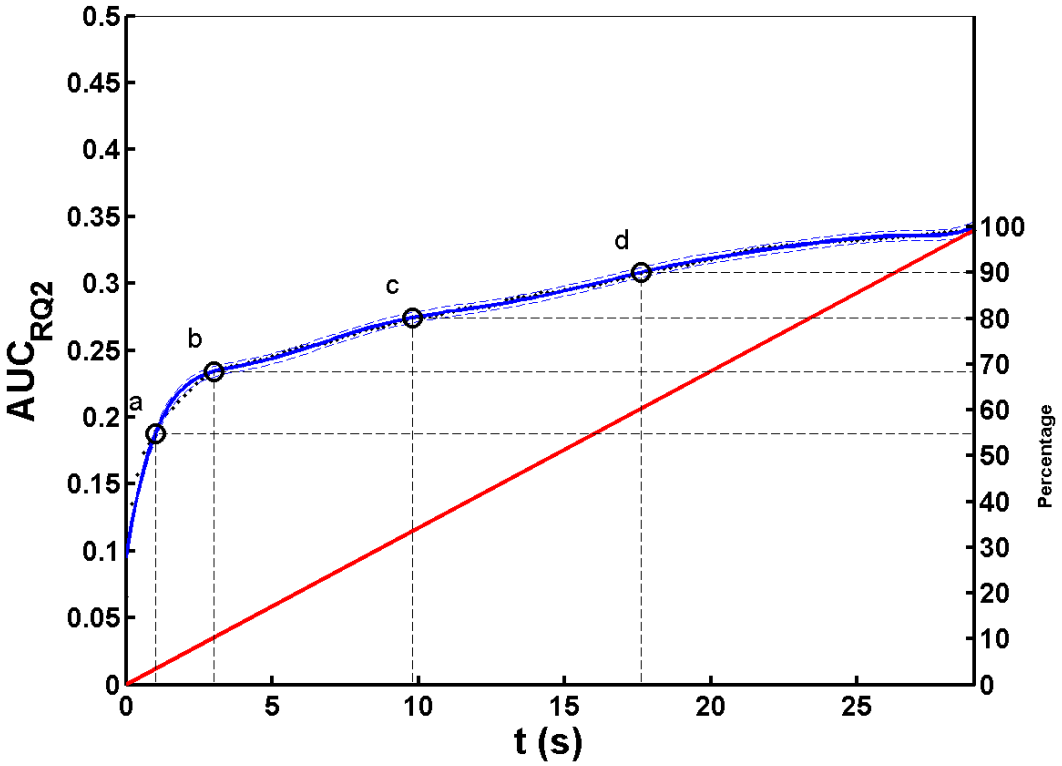
- enabling and advancing





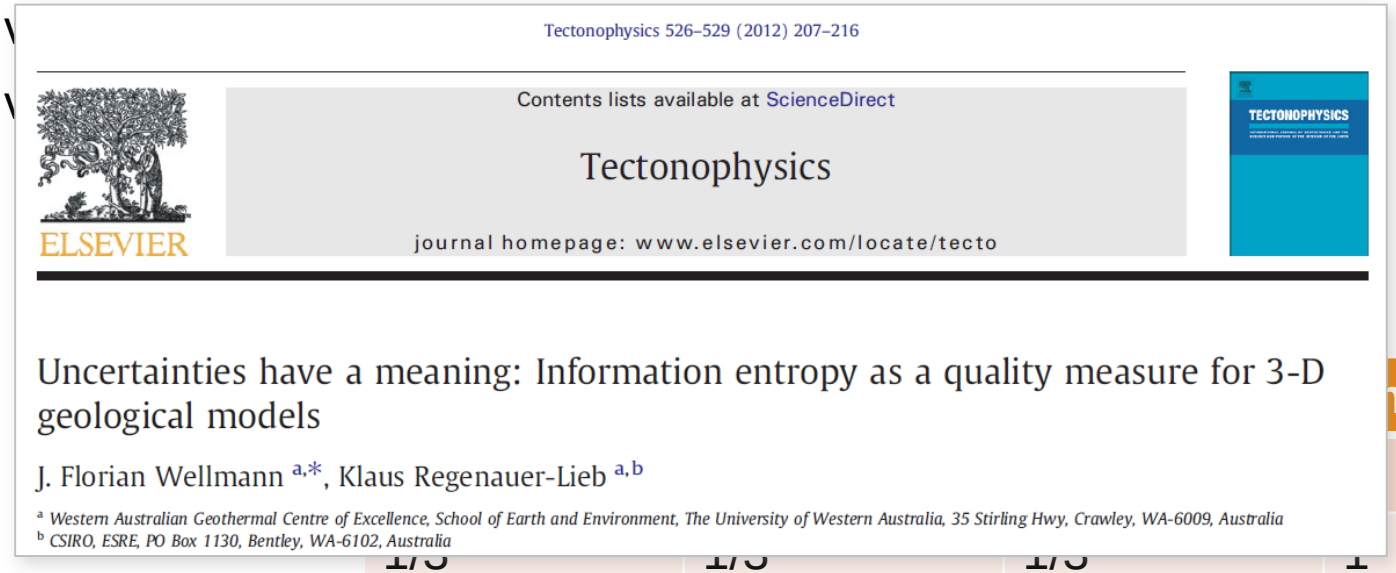



SIZE
matters


AUC_RQ2
t (s)
Percentage
a
b
c
d
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
100
90
80
70
60
50
40
30
20
10
0

INFORMATION ENTROPY

- Measure of uncertainty, with the following properties:
  - \
  - \



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ELSEVIER

Uncertainties have a meaning: Information entropy as a quality measure for 3-D geological models

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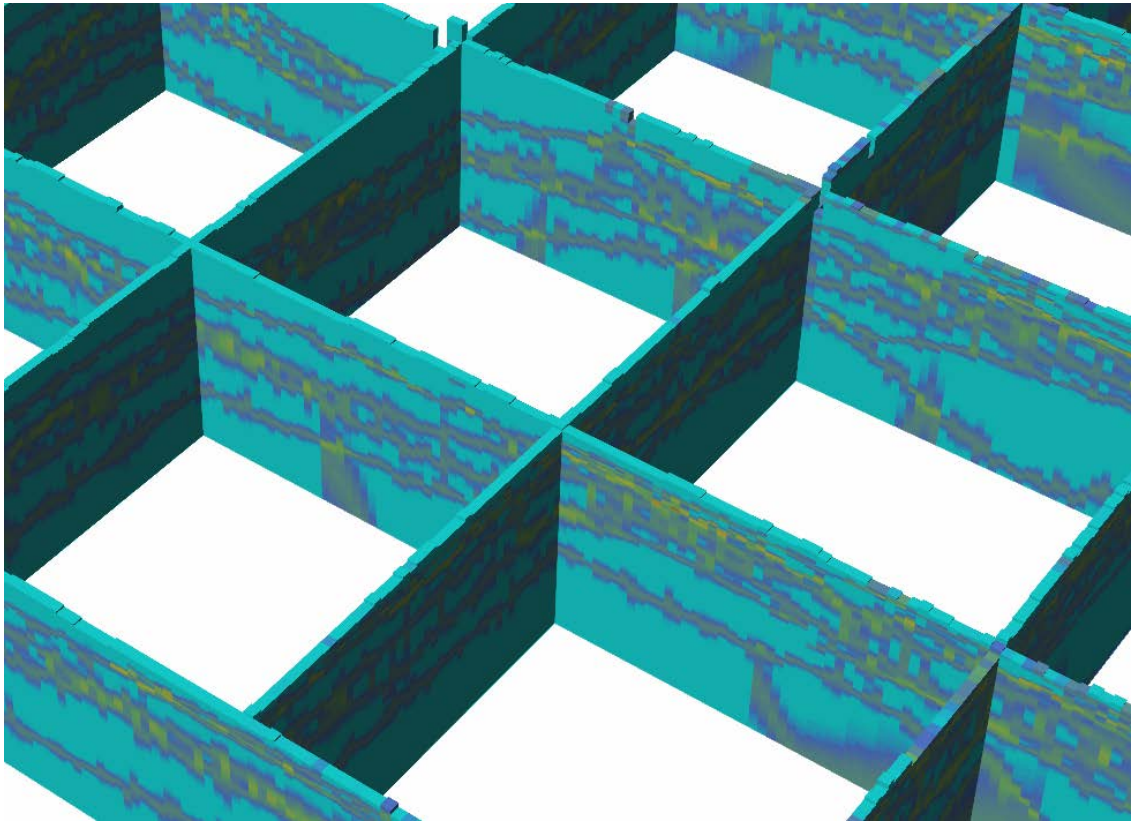
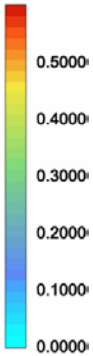
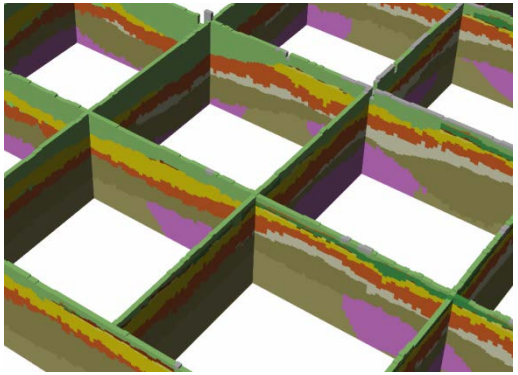
			ntropy (H)
1/3	1/3	1/3	1
0.5	0.5	0	0.63
0.49	0.49	0.02	0.71

$$H = -1 * (p_1 \, {}^3\log p_1 + p_2 \, {}^3\log p_2 + p_3 \, {}^3\log p_3)$$

INFORMATION ENTROPY

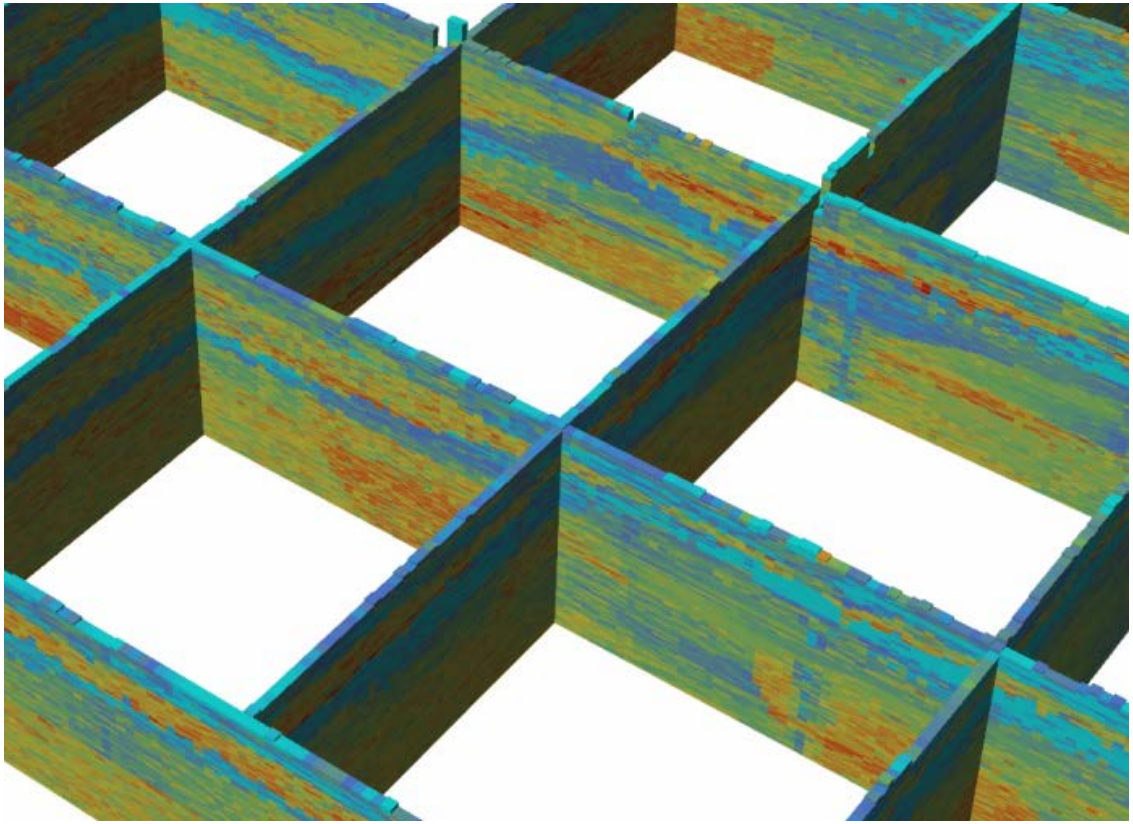


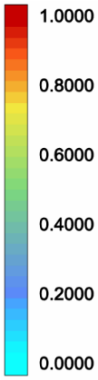


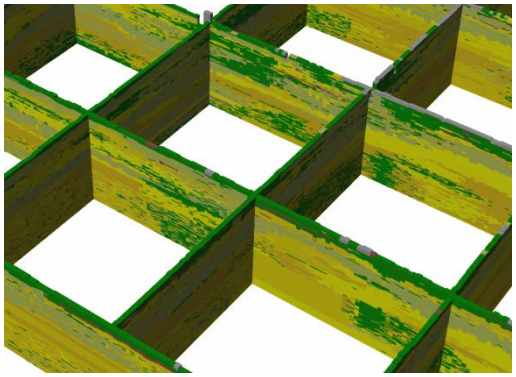


lithostratigraphy

INFORMATION ENTROPY







most likely lithoclass


DEMO