28/04/2017

Voxel modelling sands and gravels of Pleistocene Rhine and Meuse in Flanders (Belgium)

van Haren, Dirix, De Koninck

Flemish Knowledge Centre of the Subsurface (VLAKO)
part of VITO and Flemish Government

Outline

1. Introduction
2. Why voxel modelling?
3. Sands and gravels as a resource
4. Voxel model methodology
5. Results
6. Lessons learned

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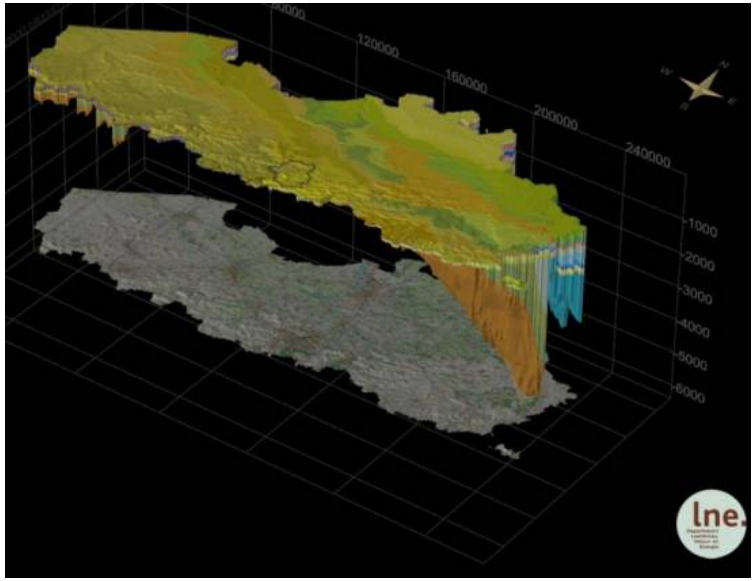
1. Introduction

Introduction

- Voxel model part of geological 3D layer model of Flanders, Belgium
  - Area: Flanders and Brussels Capital Region
  - Free accessible @ http://dov.vlaanderen.be

www.dov.vlaanderen.be



www.dov.vlaanderen.be

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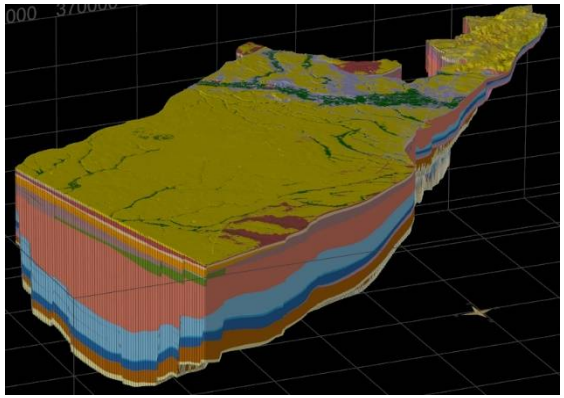
Introduction

2006: start

2011: first modelling results

2013: 1st complete layer model

2015: 1st voxel model



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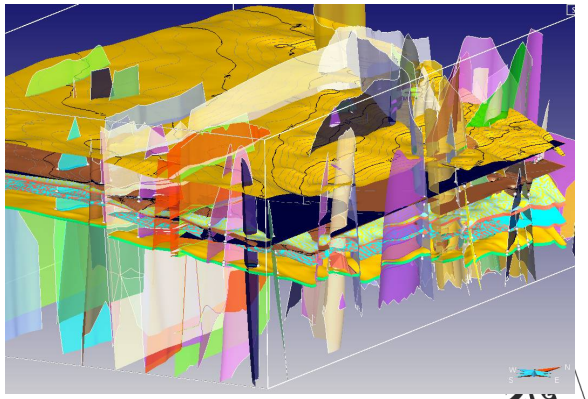

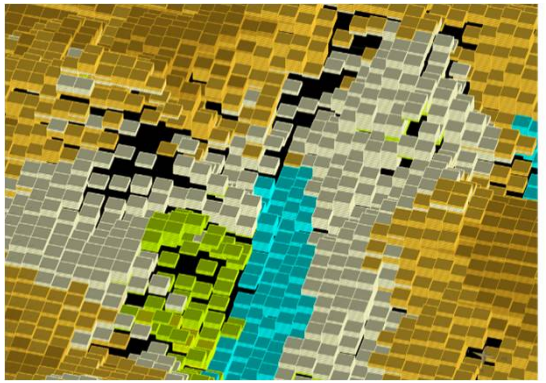

(Van Haren, 2017)

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2. Why voxel modelling?

Why voxel modelling?

» Ordered by Flemish Government – Natural Resources Service

Support of:

1. Management of the (deep) subsoil
2. Geological knowledge: policy-supporting research & data sharing
3. Resource Policy

» To enrich the geological framework with more substantive resource information

» Focus on superficial Quaternary resources

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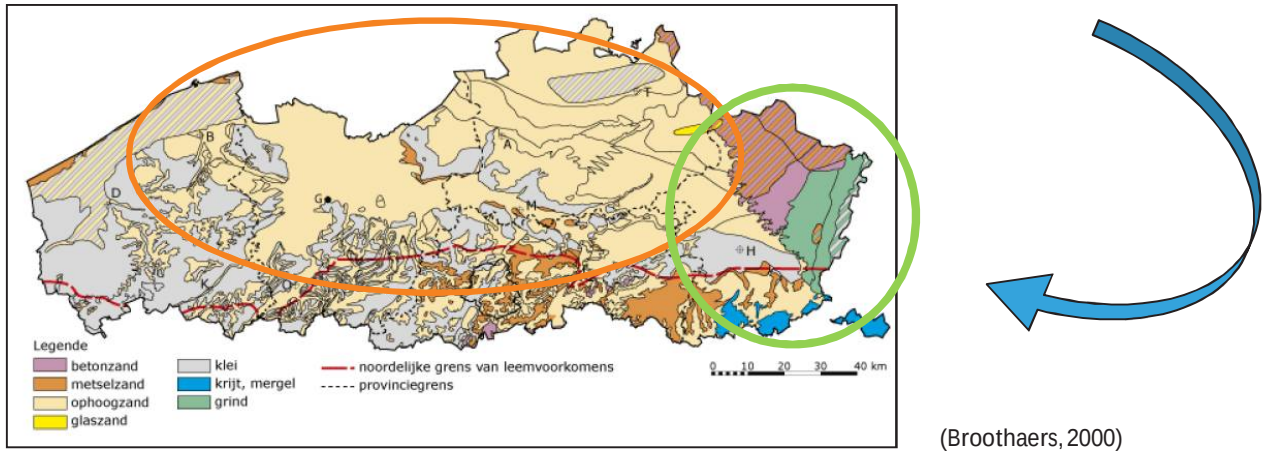
3. Sands and gravels as a resource

Sand and gravel resources

- Heterogeneous Rhine and Meuse coarse sands and gravels are of high interest

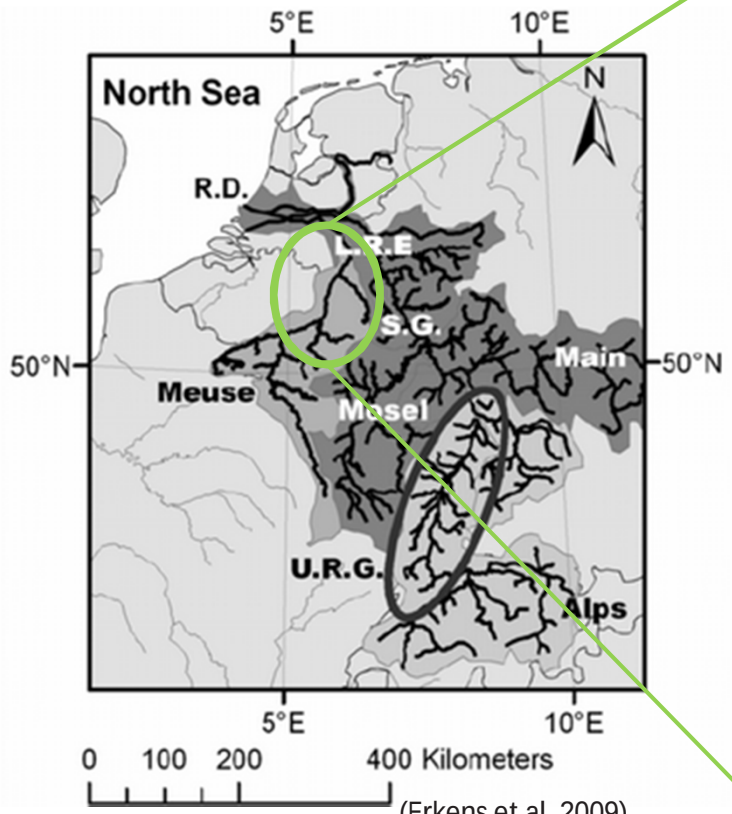


(Broothaers, 2000)

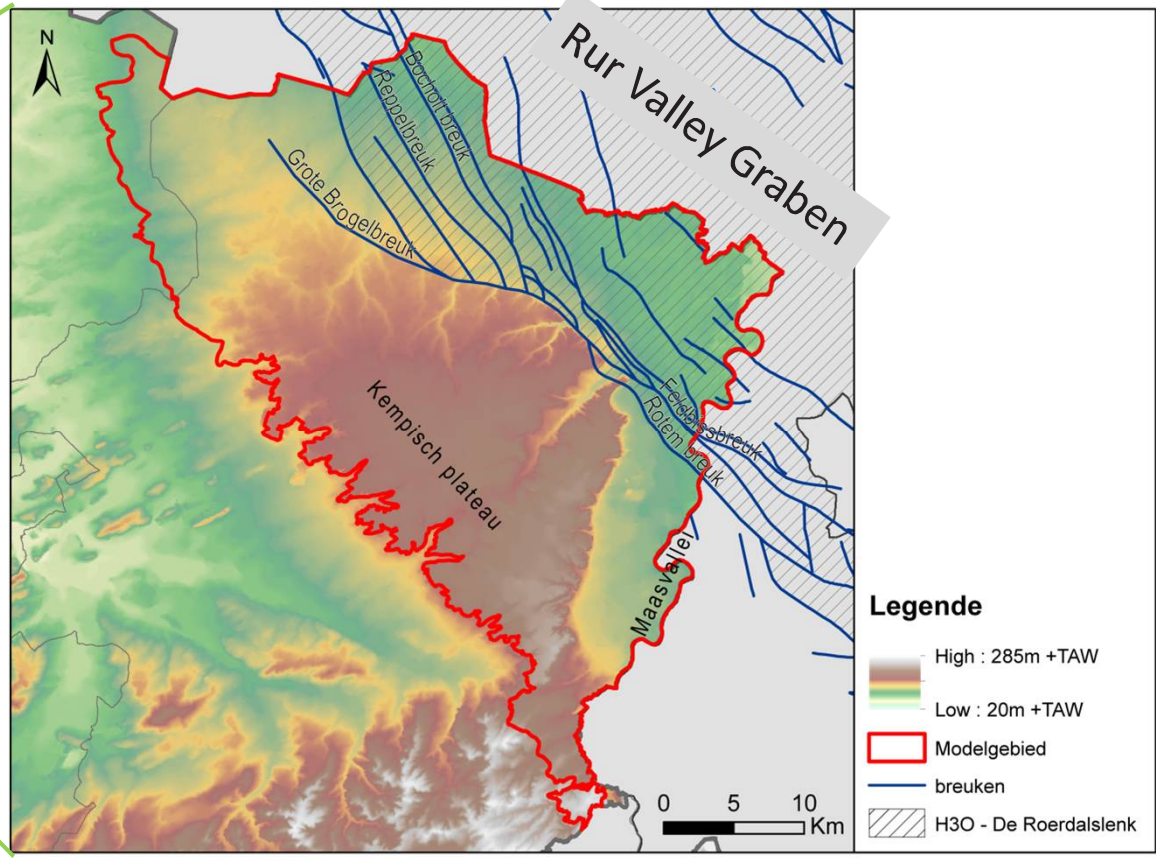
- Applications of these sands and gravel mainly in construction and building-materials industry

Area of interest

» Sands and gravels of Pleistocene Rhine and Meuse deposits



(Erkens et al. 2009)



(van Haren et al. 2016)

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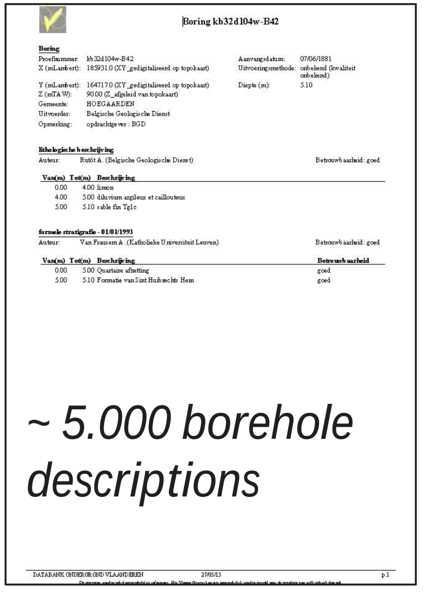
Modelling resource potential of sands and gravel

- Resource characteristics
  - Grain size and granulometric composition
  - Lithological composition
  - Grain form
  - Hardness
  - Color
  - Mineral composition
  - ...

Resource potential vs. data input

- What resource parameters can be modelled?
  - Grain size and granulometric composition
  - Lithological composition
  - Grain form
  - Hardness
  - Color
  - Mineral composition



Boring kb32d104w-B42

Boring

Proefnummer:	kb32d104w-B42	Aanvangsdatum:	07/06/1881
X (mLambert):	185931.0 (XY_gedigitaliseerd op topokaart)	Uitvoeringsmethode:	onbekend (kwaliteit onbekend)
Y (mLambert):	164717.0 (XY_gedigitaliseerd op topokaart)	Diepte (m):	5.10
Z (mTAW):	90.00 (Z_afgeleid van topokaart)		
Gemeente:	HOEGAARDEN		
Uitvoerder:	Belgische Geologische Dienst		
Opmerking:	opdrachtgever : BGD		

lithologische beschrijving

Auteur: Rutôt A. (Belgische Geologische Dienst) Betrouwbaarheid: goed

Van(m)	Tot(m)	Beschrijving
0.00	4.00	limon
4.00	5.00	diluvium argileux et caillouteux
5.00	5.10	sable fin Tgl c

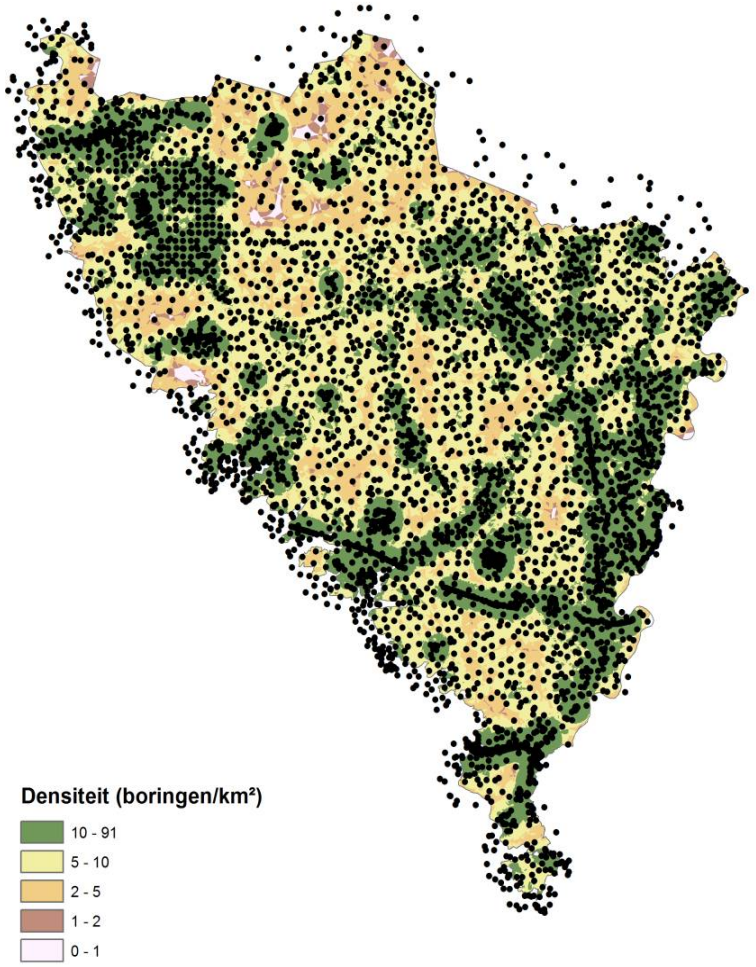
formele stratigrafie - 01/01/1993

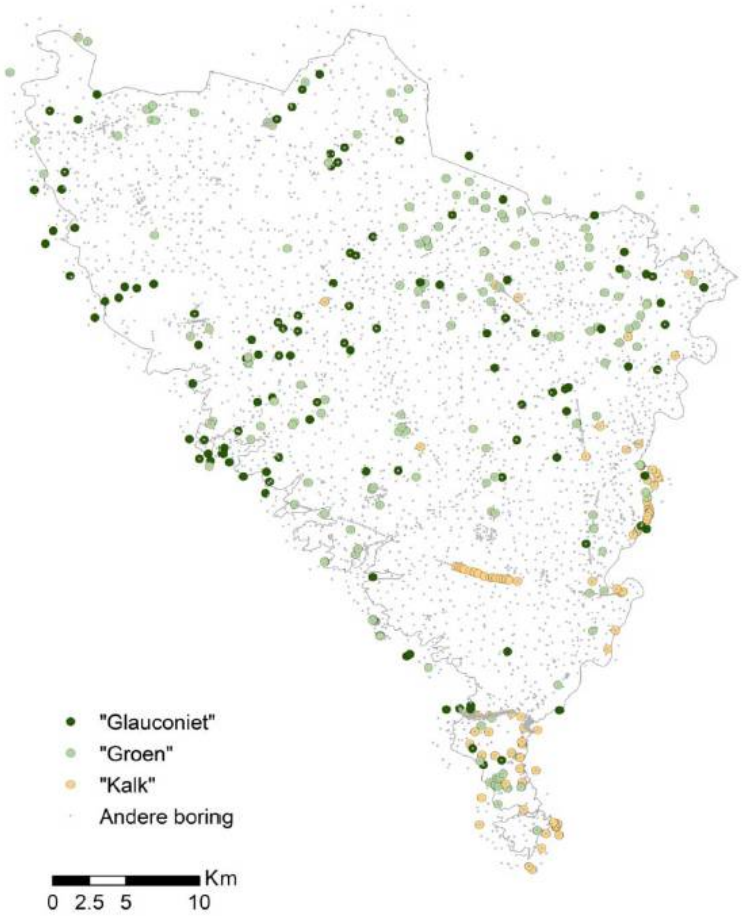
Auteur: Van Frausem A. (Katholieke Universiteit Leuven) Betrouwbaarheid: goed

Van(m)	Tot(m)	Beschrijving	Betrouwbaarheid
0.00	5.00	Quartaire afzetting	goed
5.00	5.10	Formatie van Sint Huibrechts Hern	goed

~ 5.000 borehole descriptions

Mineral examples: glauconite, chalk content





(van Haren et al, 2017)

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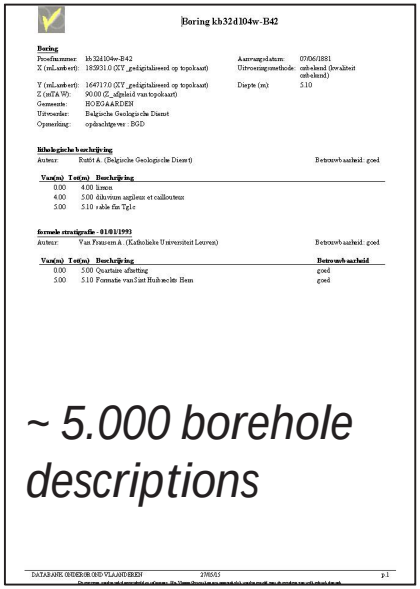
Resource potential vs. data input

- What resource parameters can be modelled?
  - Grain size and granulometric composition
  - Lithological composition
  - Grain form
  - Hardness
  - Color
  - Mineral composition



Boring kb32d104w-B42

Boring
Proefnummer: kb32d104w-B42
X (mLambert): 183931.0 (XY_gedigitaliseerd op topokaart)
Y (mLambert): 164717.0 (XY_gedigitaliseerd op topokaart)
Z (mTAW): 90.00 (Z_afgeleid van topokaart)
Gemeente: HOEGAARDEN
Uitvoerder: Belgische Geologische Dienst
Opmerking: opdrachtgever : BGD
Aanvangsdatum: 07/06/1881
Uitvoeringsmethode: onb-kleend (onvolledig onb-kleend)
Diepte (m): 5.10

Lithologische beschrijving
Auteur: Rutot A. (Belgische Geologische Dienst)
Betrouwbaarheid: goed

Van(m)	Tot(m)	Beschrijving
0.00	4.00	limon
4.00	5.00	dihivium sagleux et cailloutoux
5.00	5.10	sable fin Tglc

formele stratigrafie - 01/01/1993
Auteur: Van Franeem A. (Katholieke Universiteit Leuven)
Betrouwbaarheid: goed

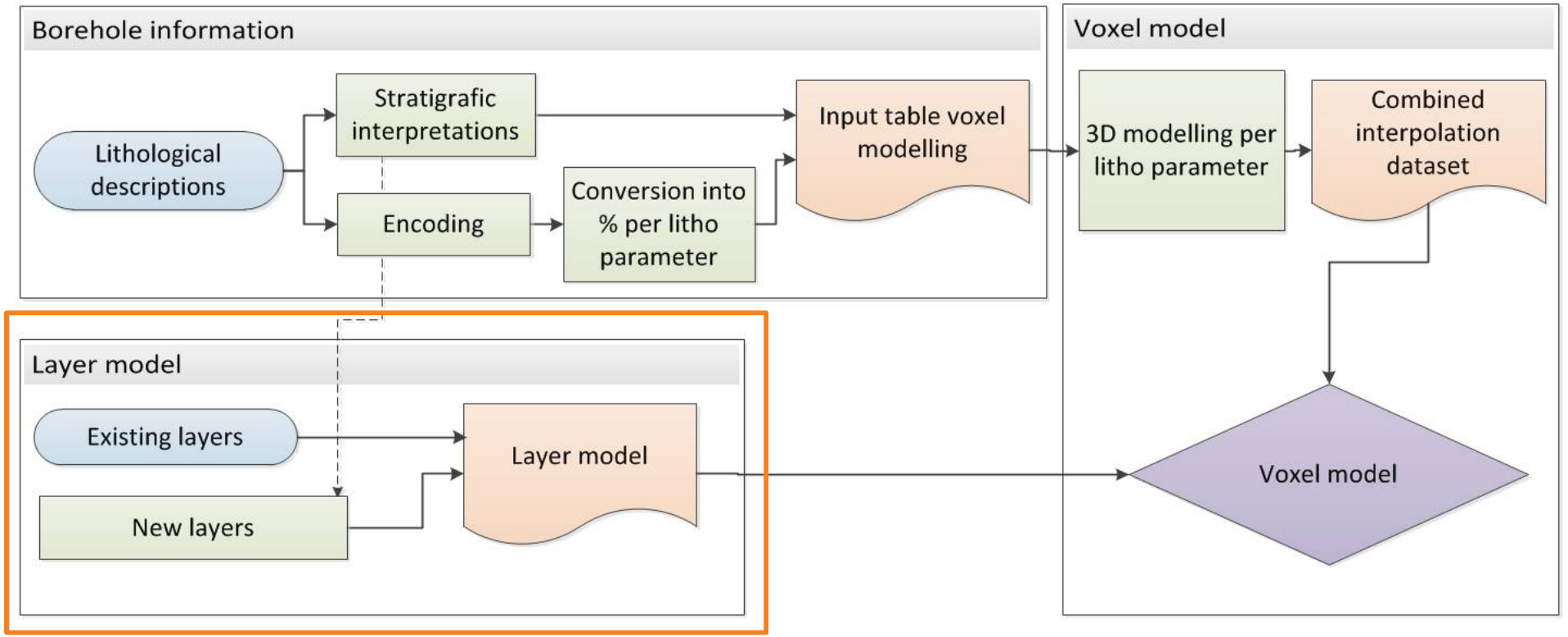
Van(m)	Tot(m)	Beschrijving	Betrouwbaarheid
0.00	5.00	Quartaire afzetting	goed
5.00	5.10	Formatie van Sint Huibrechts Hern	goed

DATABANK ONDERGROND VLAANDEREN 2/06/15 p.1

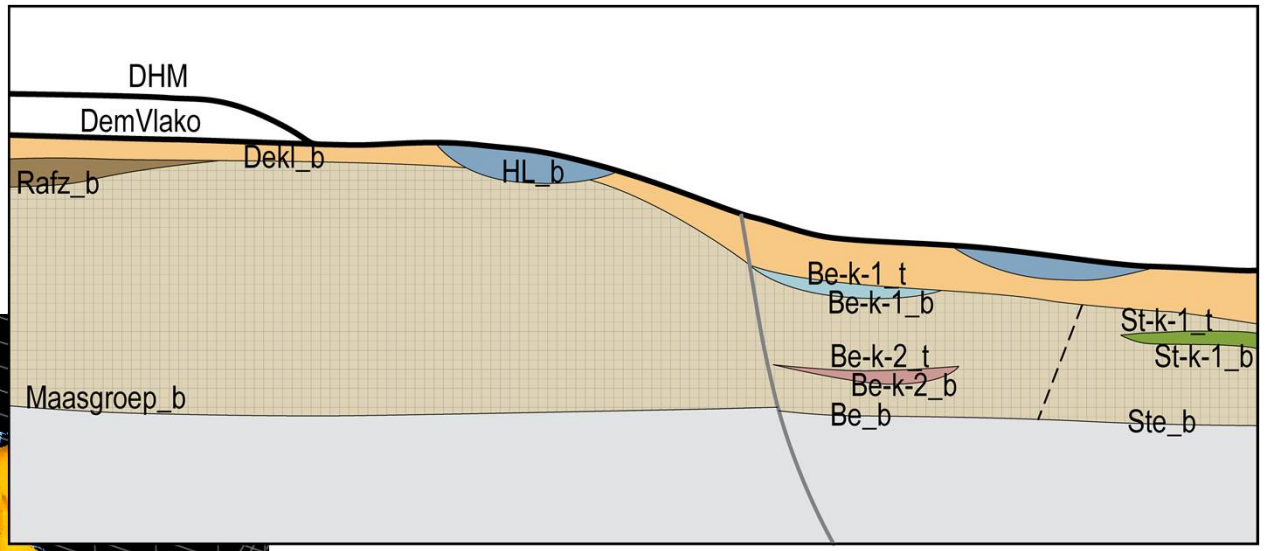
~ 5.000 borehole descriptions

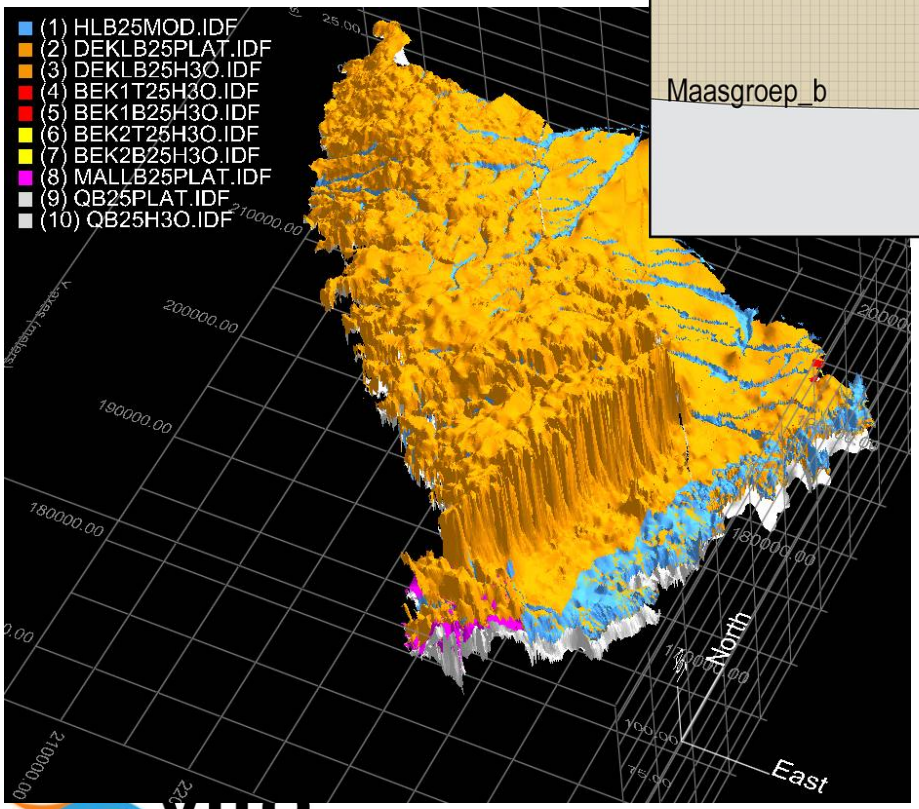
4. Voxel model methodology

General workflow



Layer model

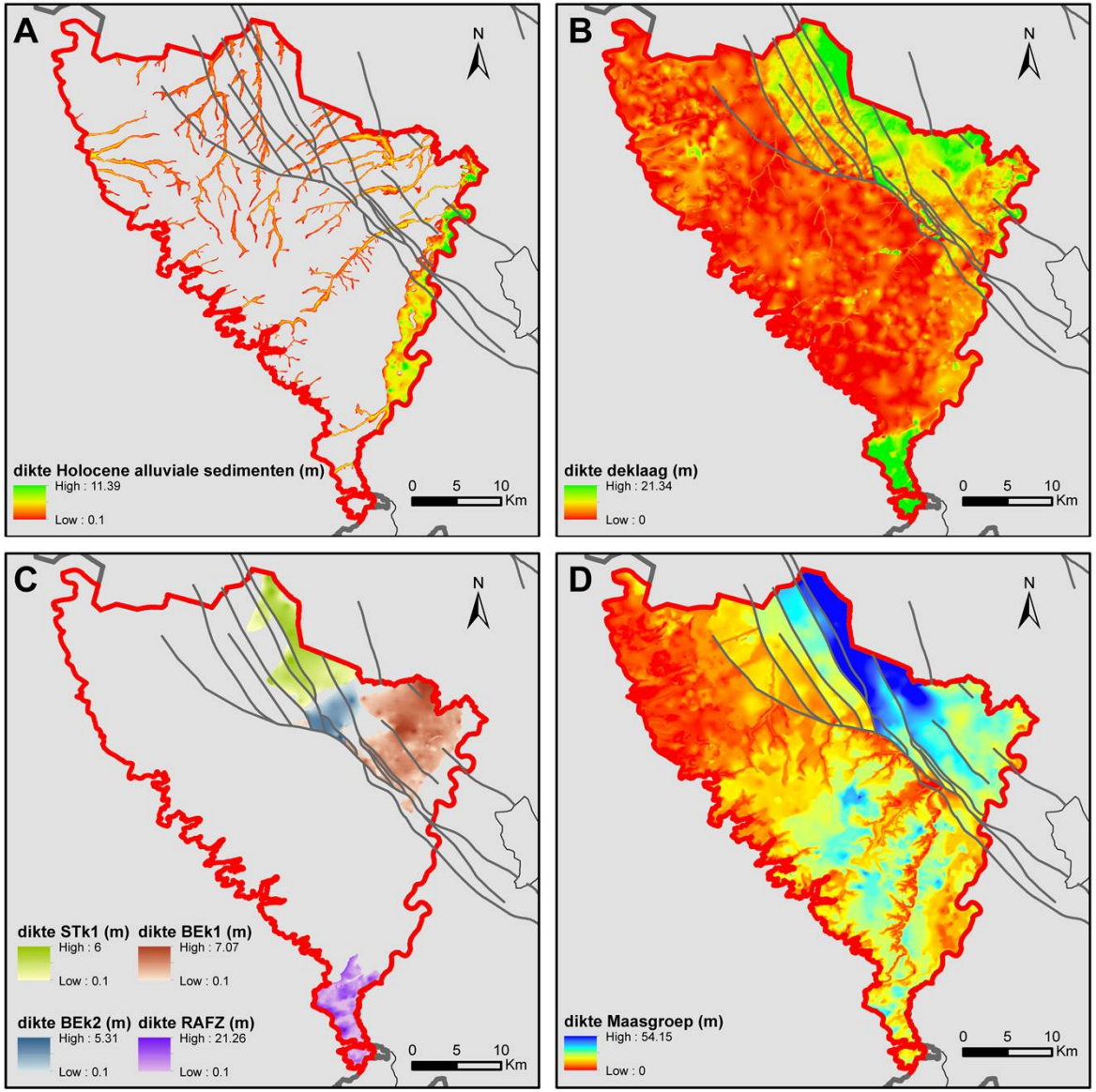




(van Haren et al., 2017)

Layer model

Thickness maps:
A: Holocene alluvium
B: coversands / loess
C: Clay-intercalations
D: Rhine/Meuse sands+gravels



(van Haren et al., 2017)

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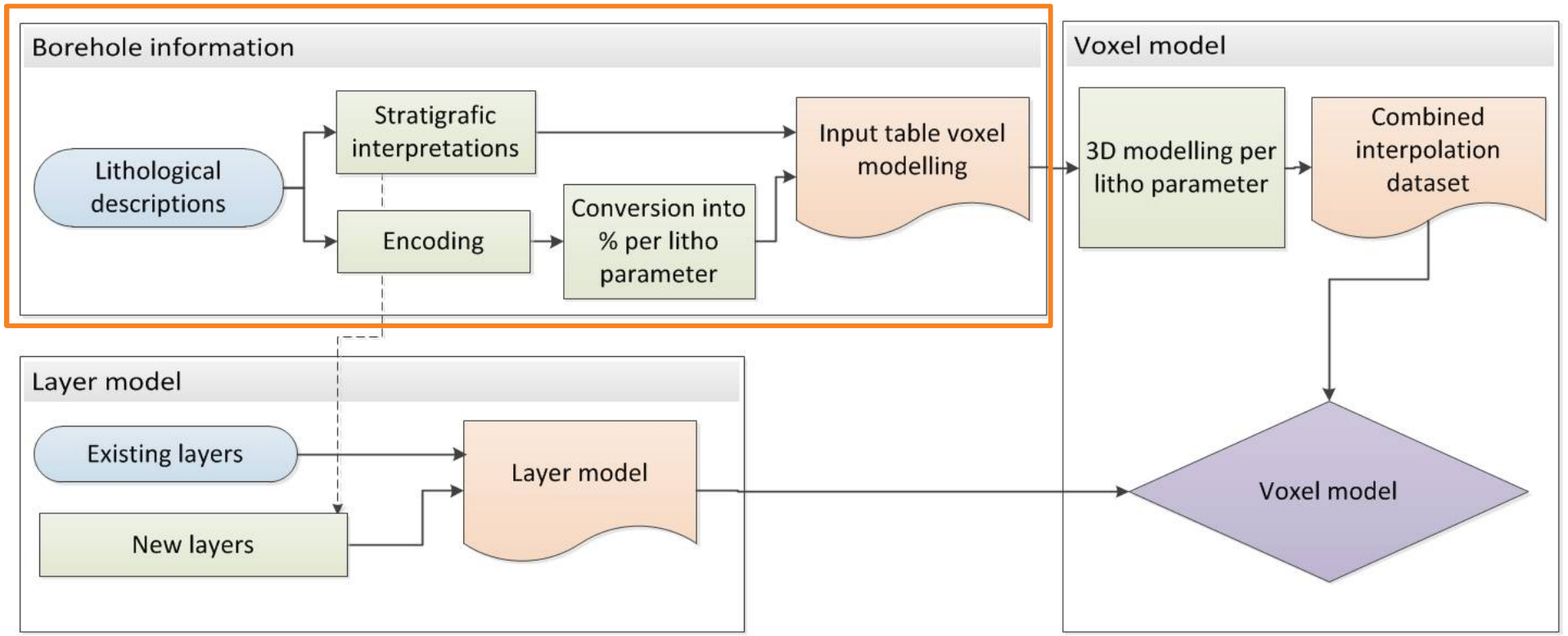
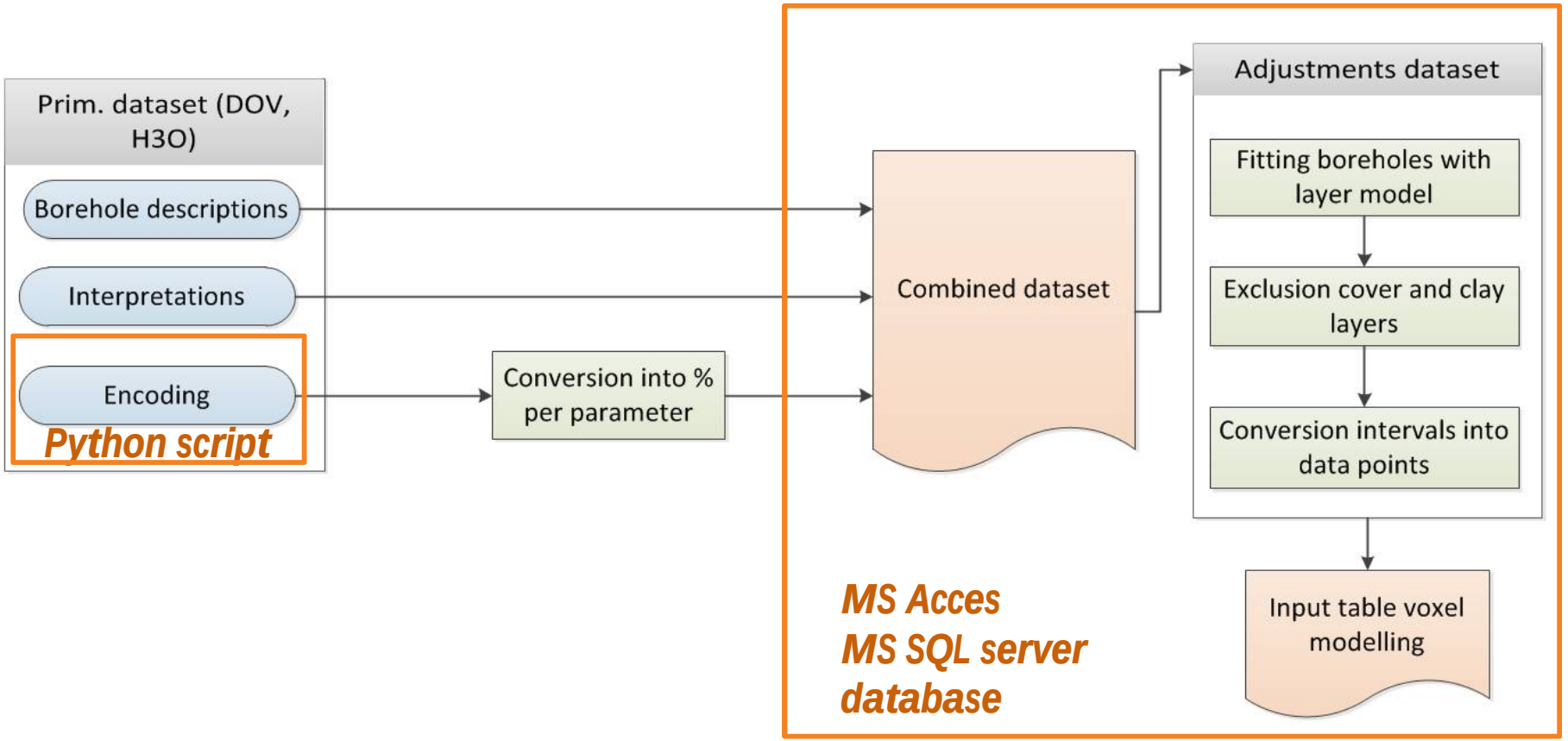
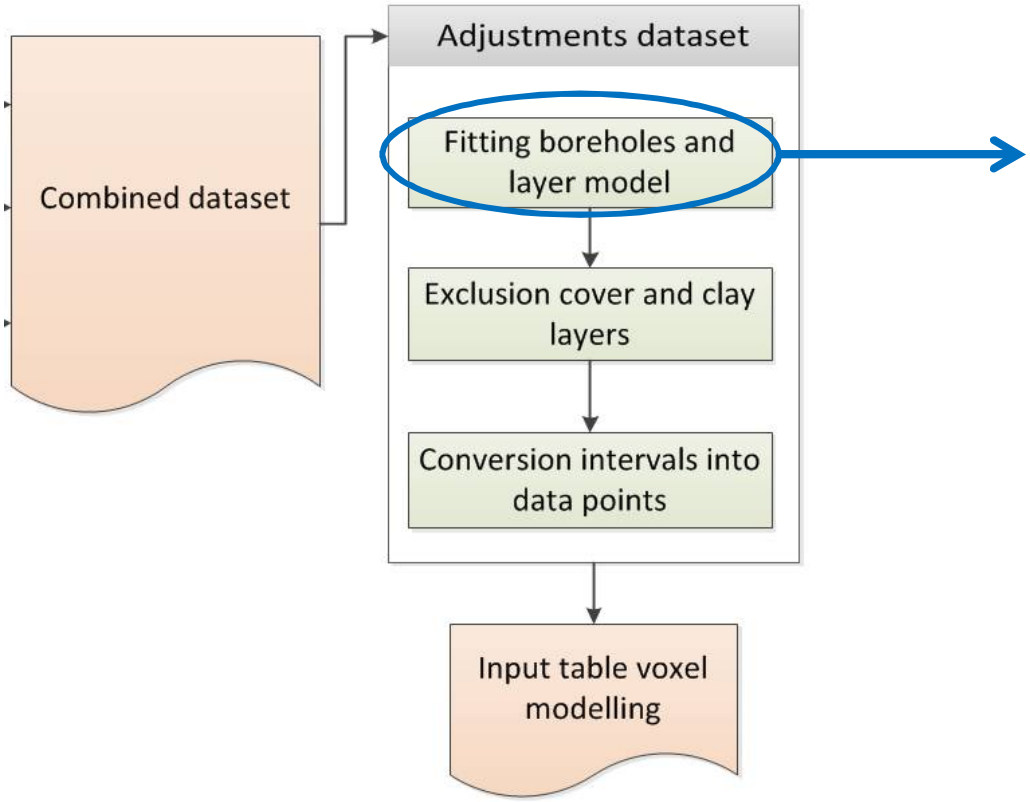
General workflow

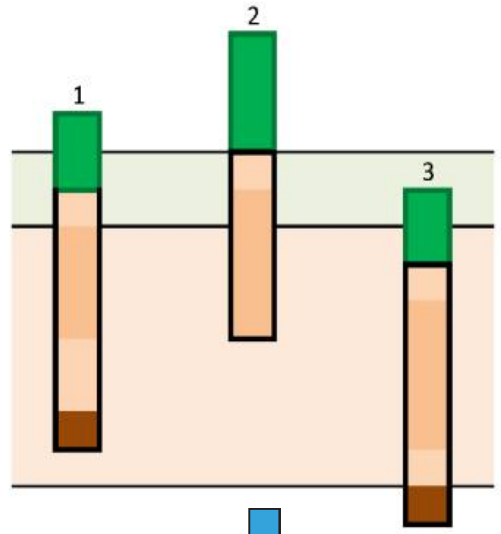


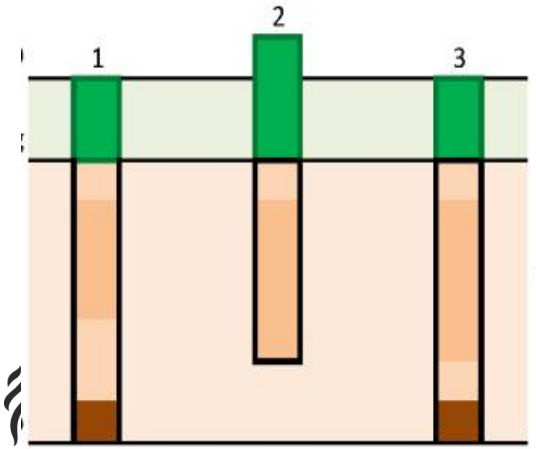
Data workflow



Adjustments dataset







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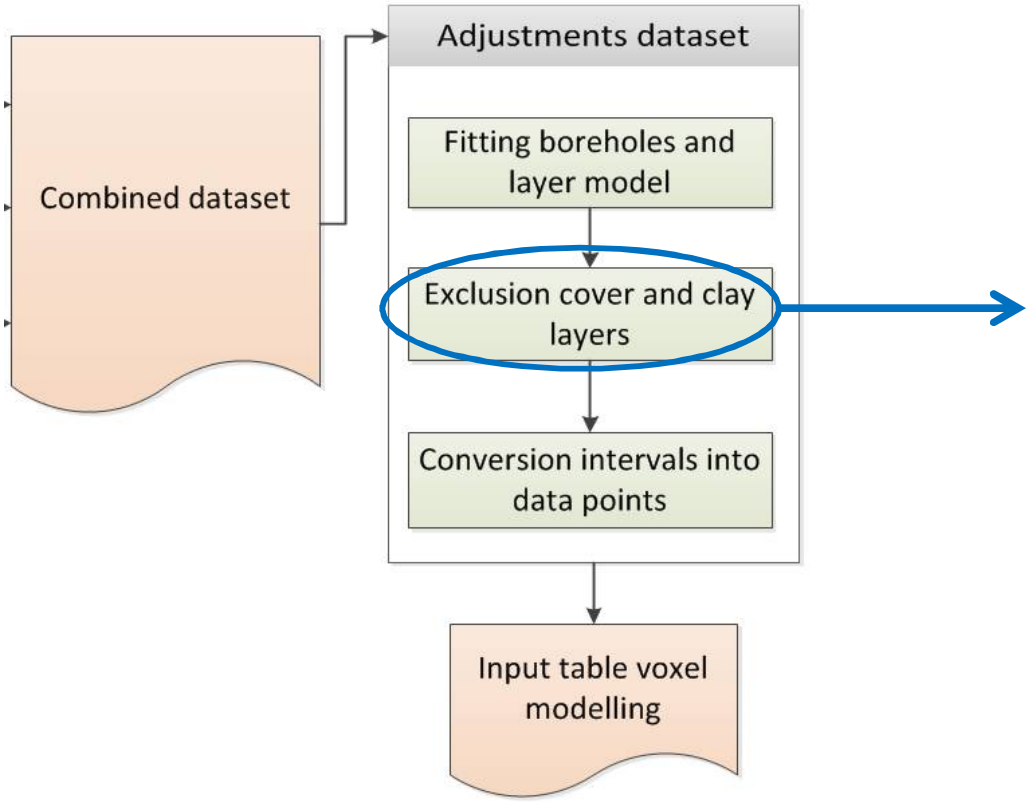
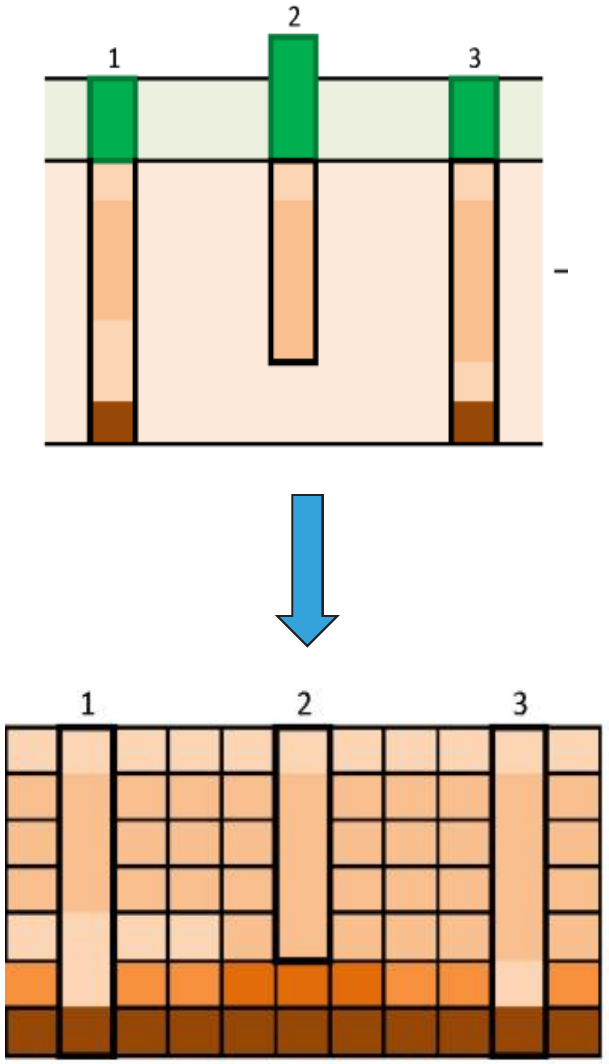
Adjustments dataset





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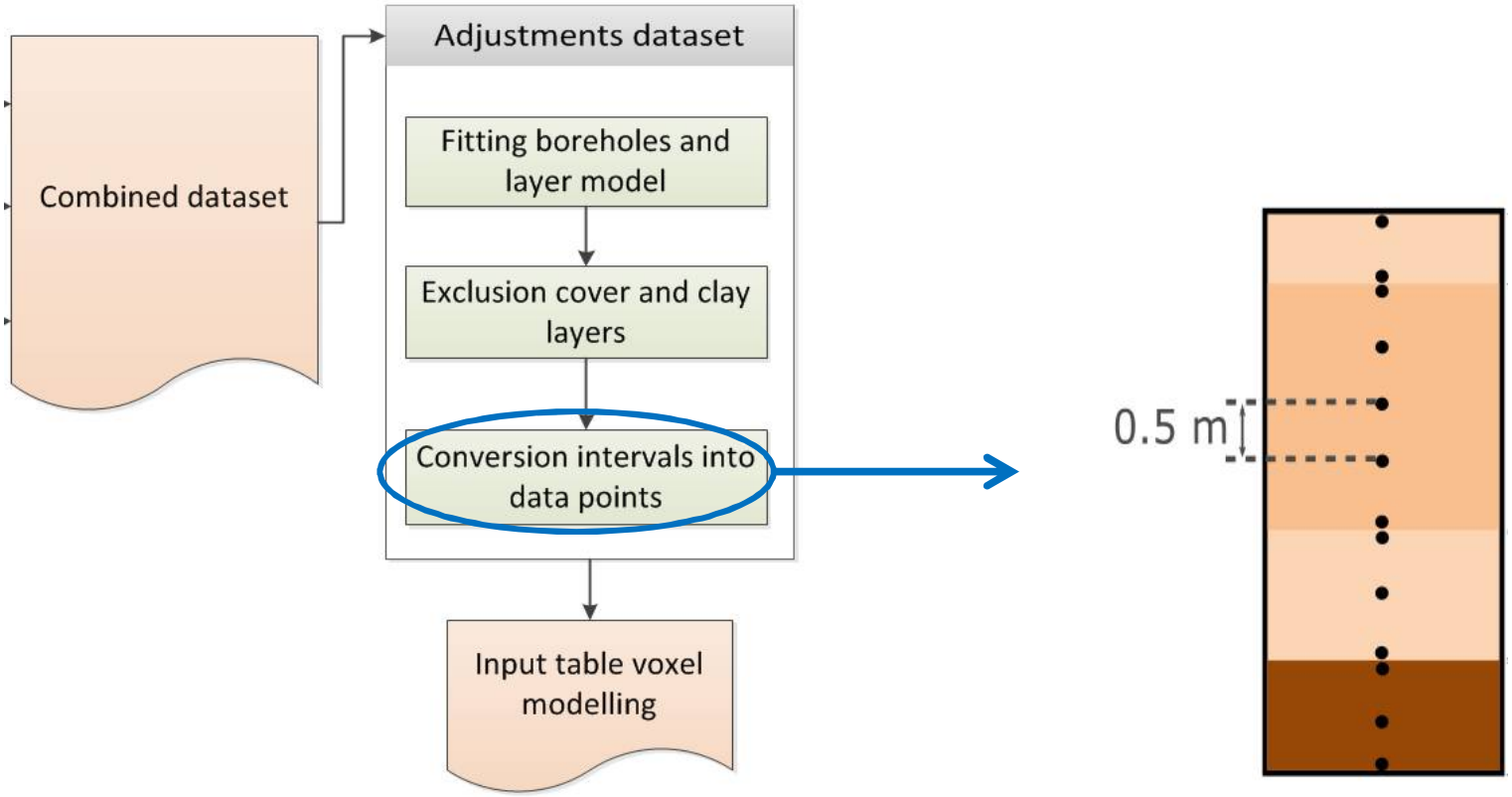
Adjustments dataset



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Resulting input table for 3D-interpolation

borehole	x	y	z	clay	fine sand	medium sand	coarse sand	gravel
B/932/22/2	231040	214203	33.84	0.75	0.15	0	0	0.1
B/932/22/2	231040	214203	33.35	0.75	0.15	0	0	0.1
B/932/22/2	231040	214203	33.33	0.15	0	0	0	0.1
B/932/22/2	231040	214203	32.83	0.15	0	0	0	0.1
B/932/22/2	231040	214203	32.33	0.15	0	0	0	0.1
B/932/22/2	231040	214203	32.30	0.15	0	0	0	0.1
B/932/22/2	231040	214203	32.28	0	0	0.1	0	0.9
B/932/22/2	231040	214203	31.78	0	0	0.1	0	0.9

"Fine sandy clay with some gravels"

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3D-interpolation

- Interpolation on every grain size parameter
- Combining interpolation results per voxel [x,y,z]
- Fixed values for voxels in cover and clay layers

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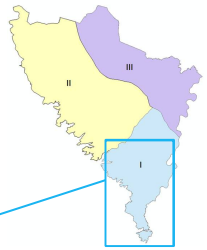
5. Results

Results



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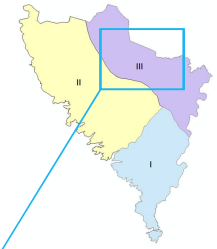
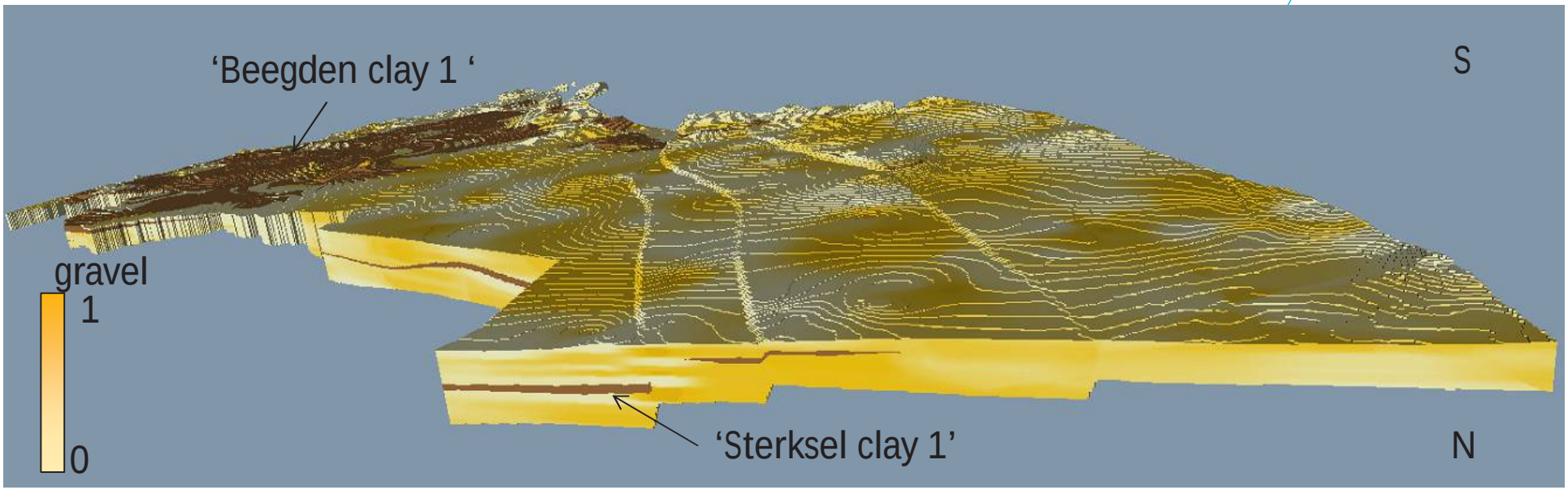
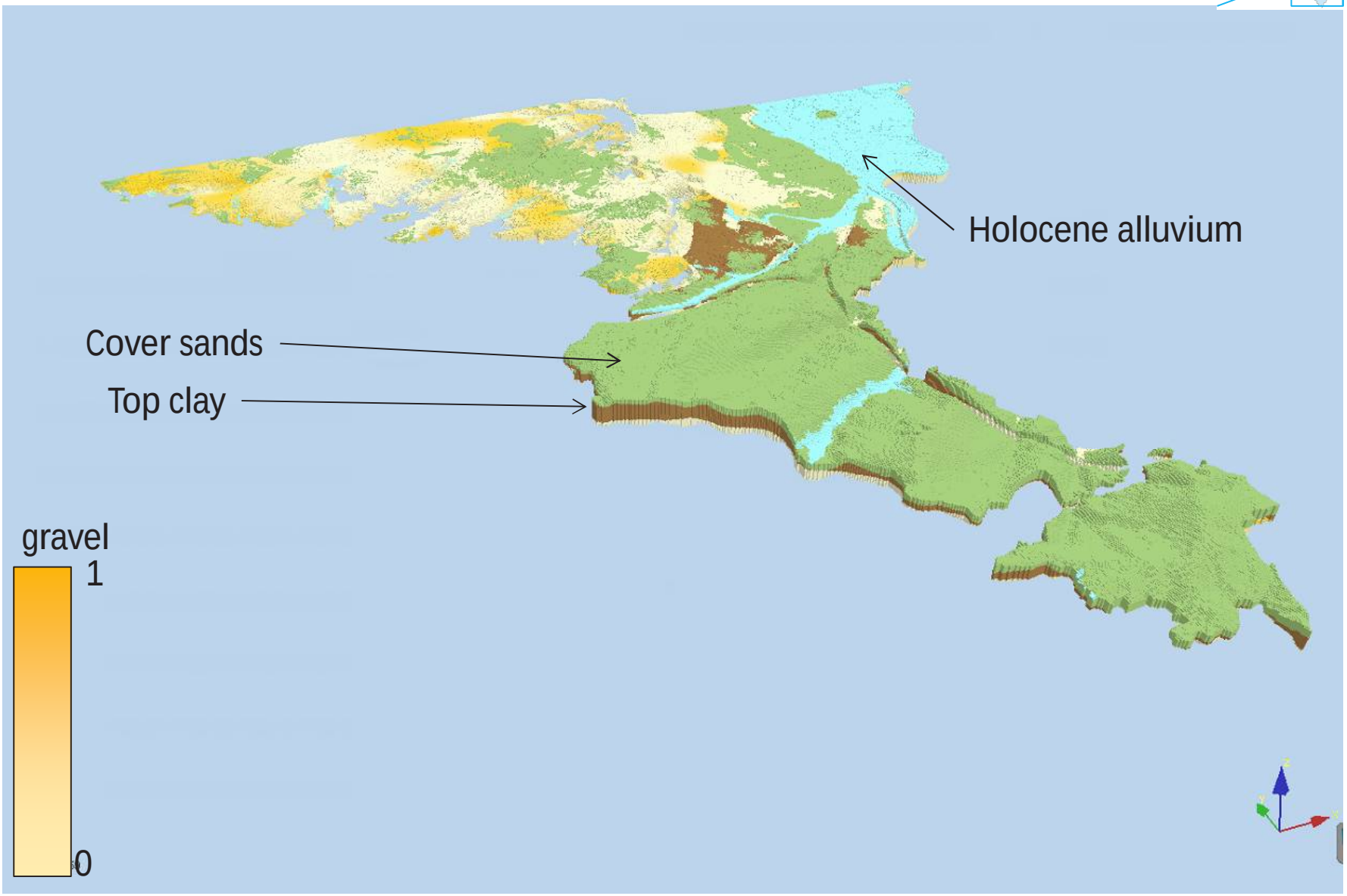
Results

- % gravel and clay intercalations



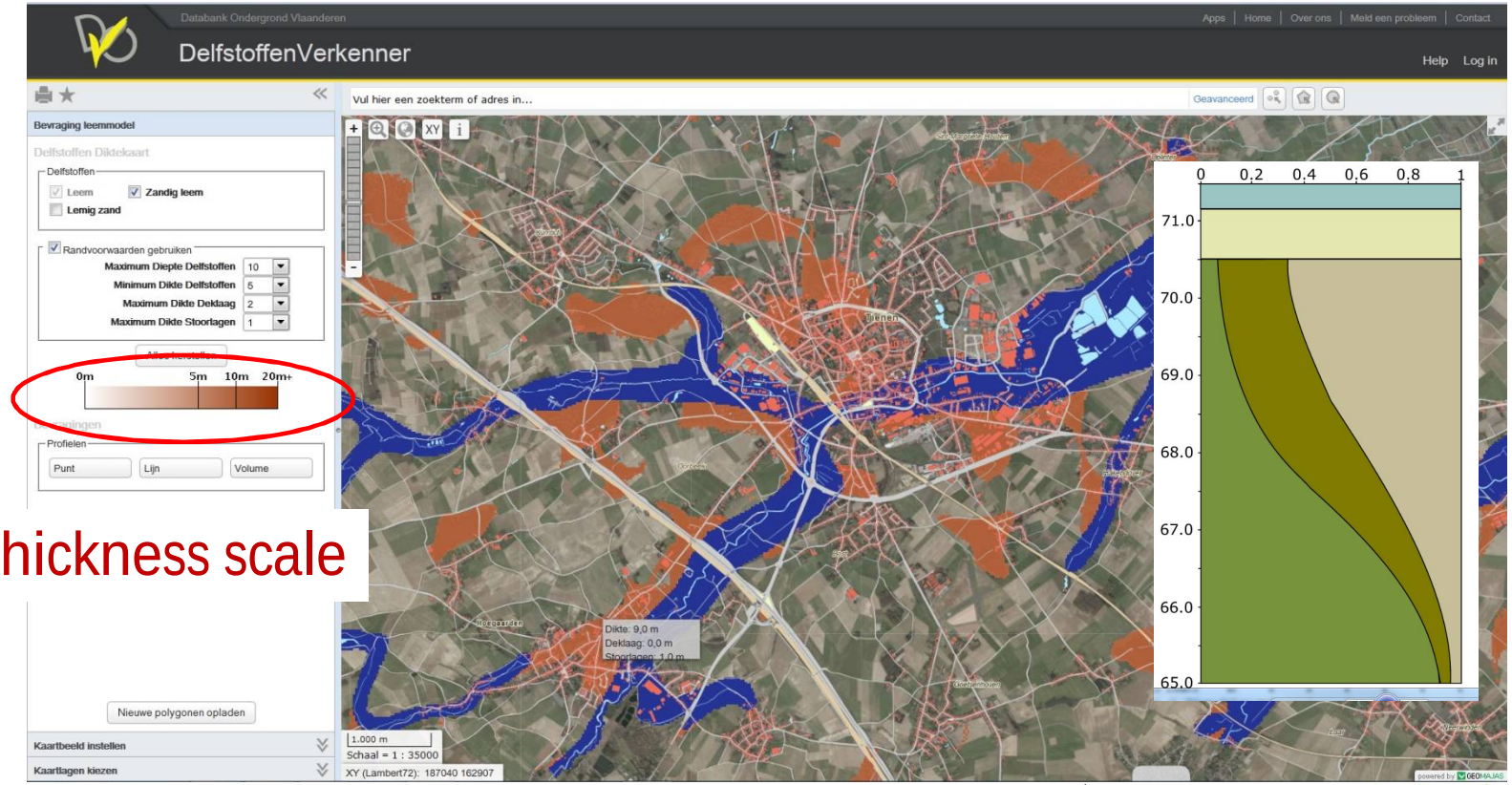


Results



Online resource viewer

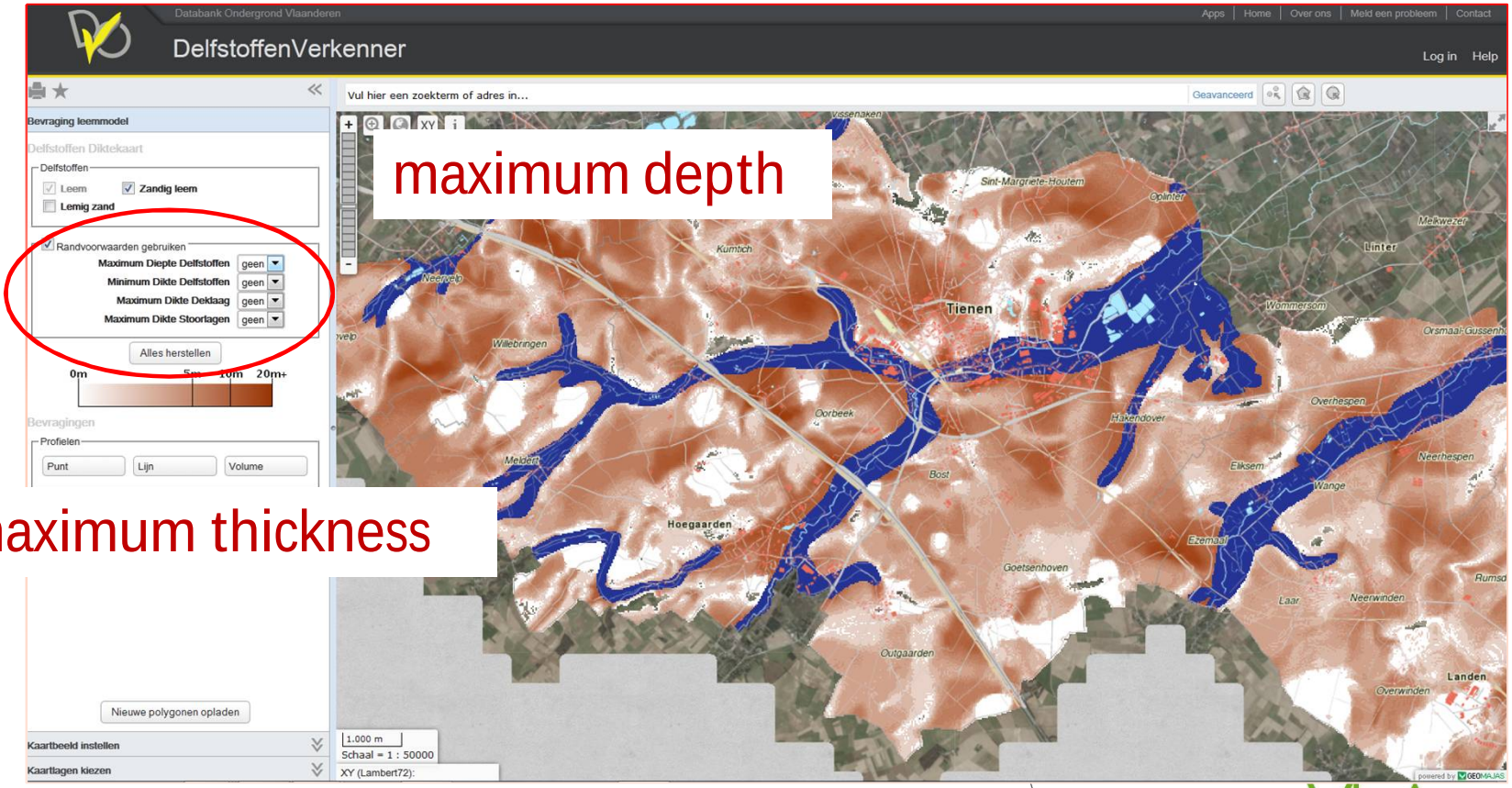
- Sands and gravel: in development
- Loess deposits are online



Thickness scale

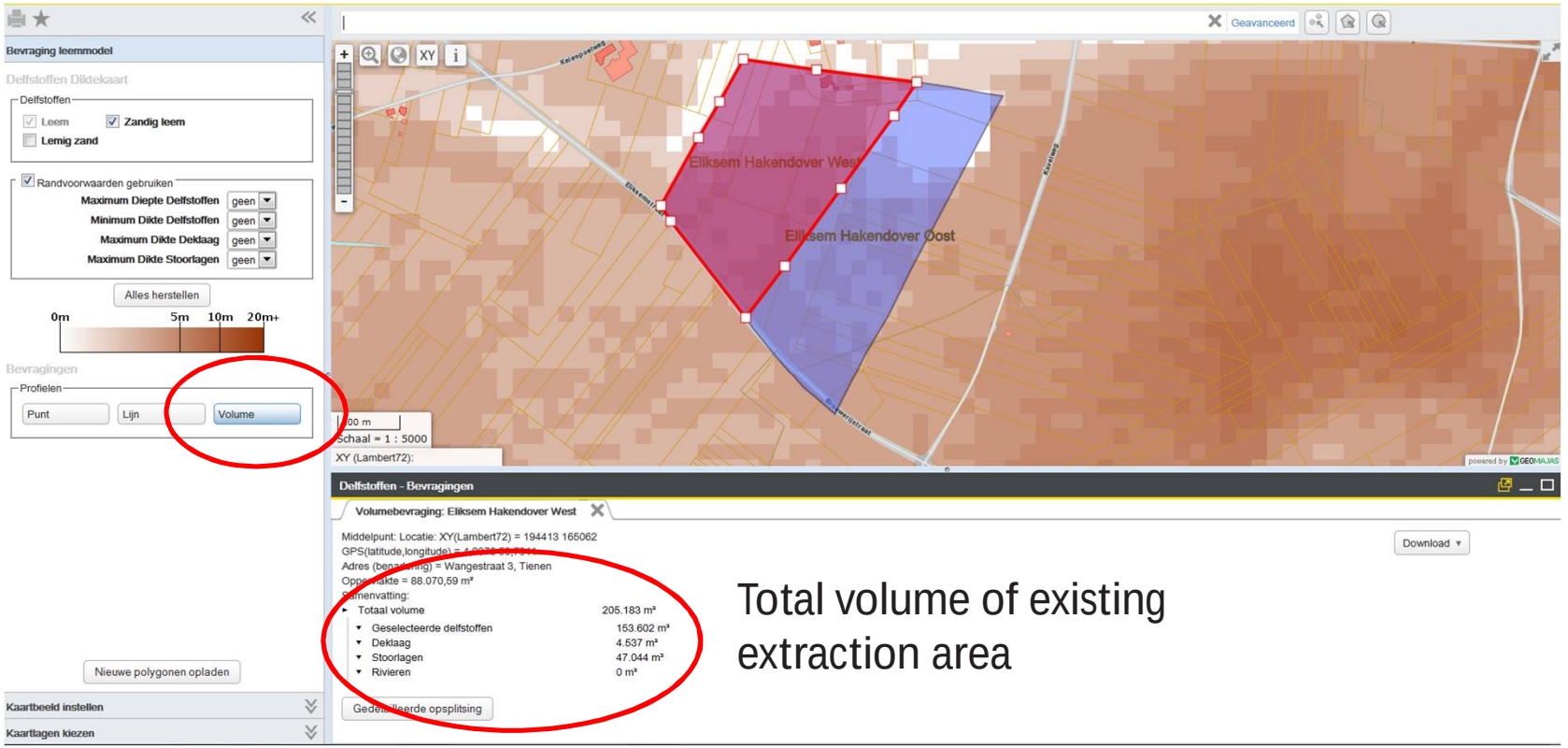
Online resource viewer

» possible to determine the extractable mineral resources based on certain preconditions



the ‘Mineral Resource Explorer’

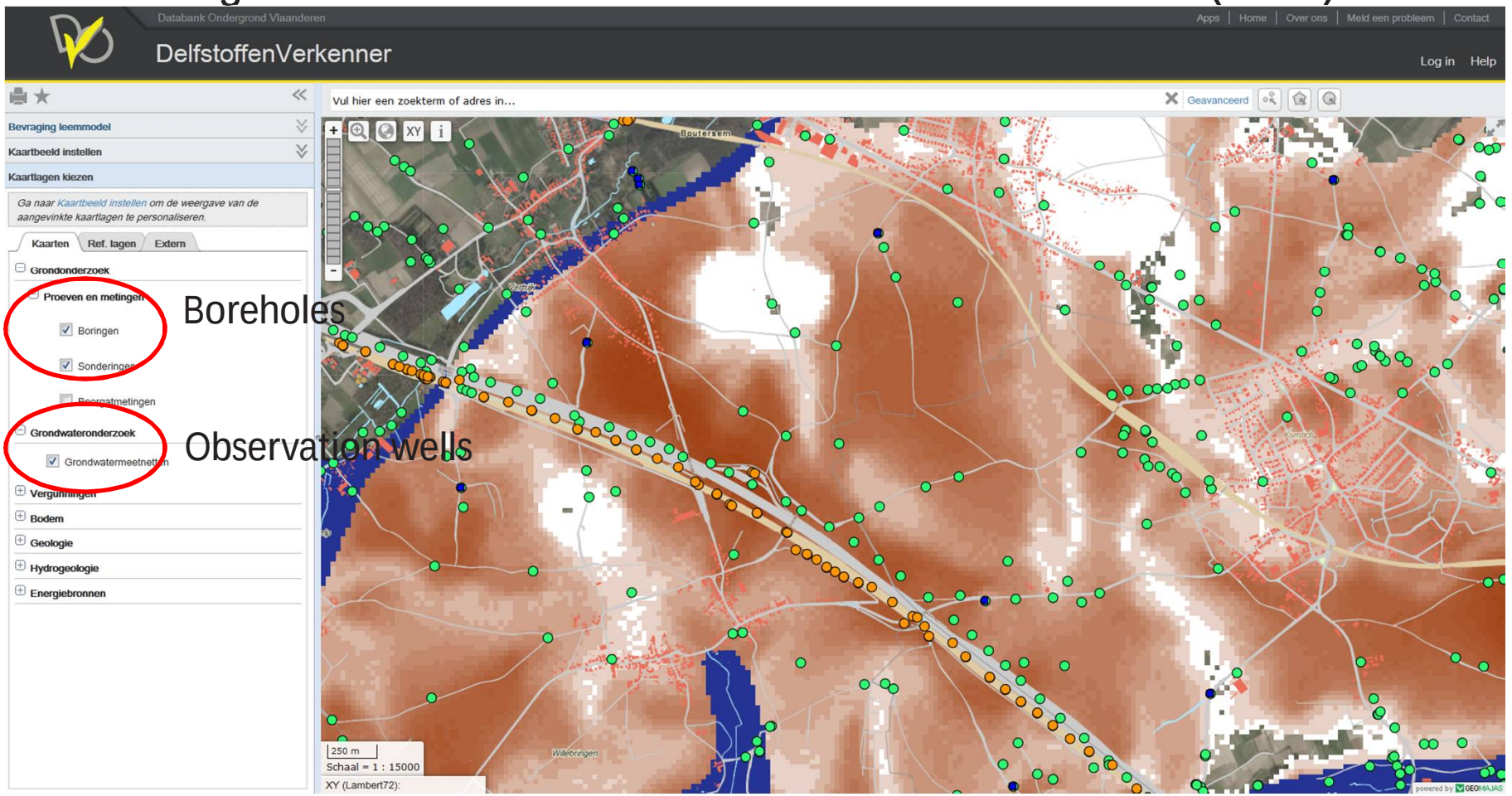
- More functionalities:
  - GIS functionalities and volume calculation



Total volume of existing extraction area

the ‘Mineral Resource Explorer’

» Integration in Flanders´ Soil and Subsoil Database (DOV)



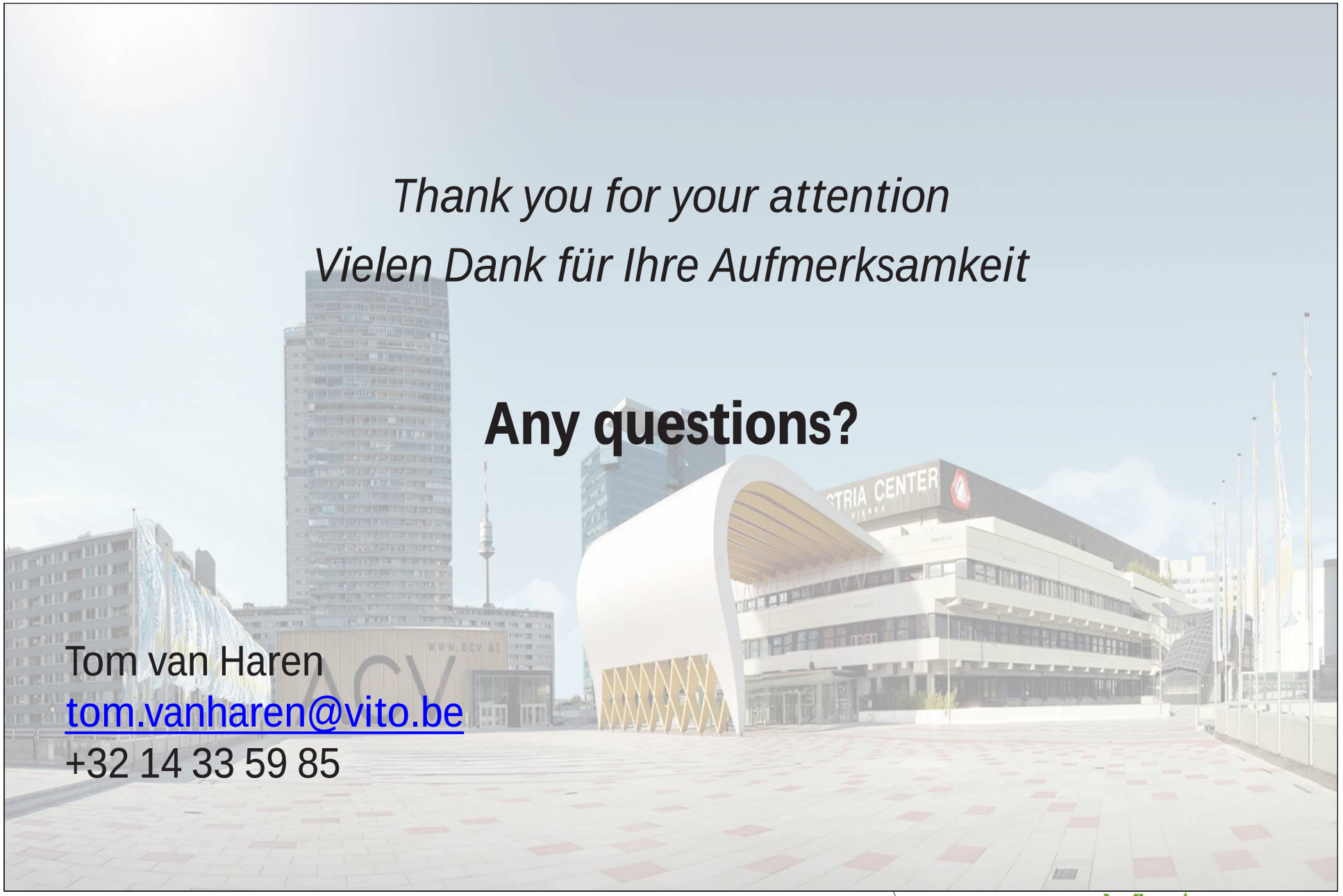
6. Lessons learned

Lessons learned

- Data analysis → significant part of modelling process prior to 3D interpolation
  - Unravelling deposit distribution
  - To understand limitations of dataset
  - Prediction of model outputs

- Database development (SQL / Access)
  - Helps data preparation
  - QC on data (errors easy traceable and adjusted)
  - automatization iterative processes
  - Filtering data out of model results

- Development online resource viewer:
  - Viewer for sand and gravel to be developed right from the beginning. Can be helpful guiding modelling process.



Thank you for your attention

Vielen Dank für Ihre Aufmerksamkeit

Any questions?

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