



# Virumaa hüdrokeoloogiline mudel ja mida sellega teha saab

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Raul Paat, Kaidi Sarv, Jane Puura, Peeter Talviste, Pille  
Sedman, Kalev Sepp



# Virumudel

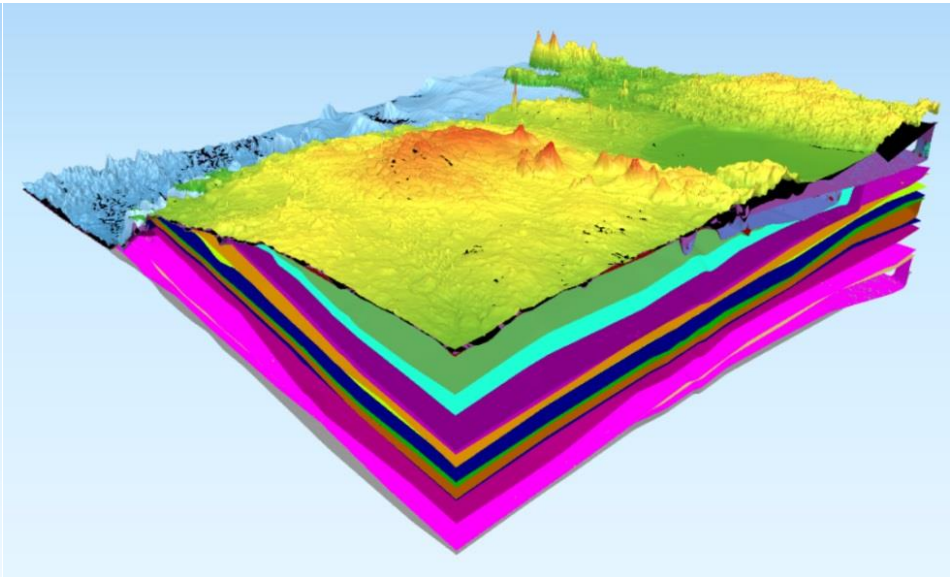
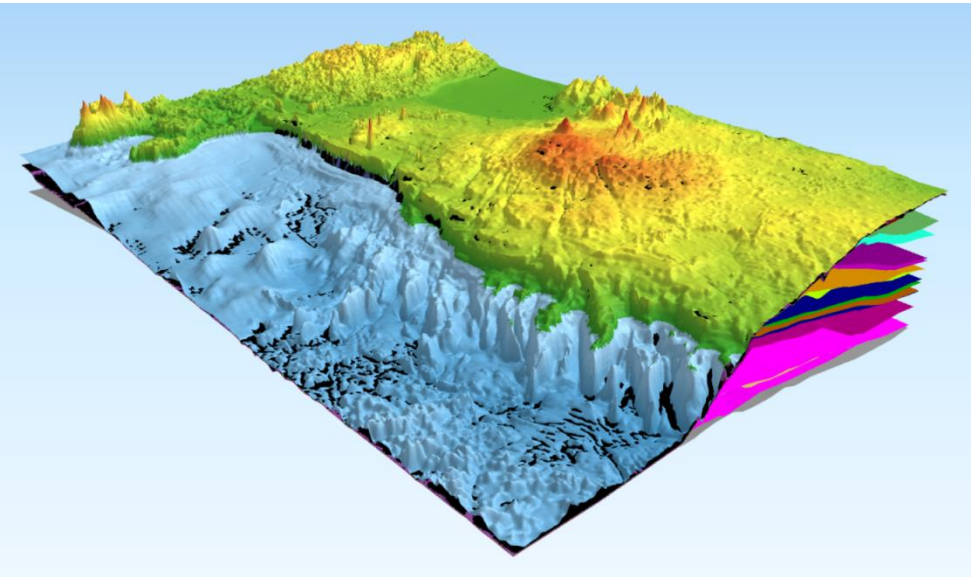
KIKi projekt 11808:

„Virumaa maavarade võimaliku kaevandamise keskkonnamõjud põhja- ja pinnaveele ning maastikule keskkonnageoloogiliste mudelitega analüüsituna koos alternatiivsete leevendusmeetmetega“

[virumudel.ut.ee](http://virumudel.ut.ee)



# Virumaade põhjaveemudel





Nr	Kiht	Lade	Kihistu
1	Q	Kvaternaar	
2	D2ar	Aruküla	
3	D2nr	Narva	
4	D1pr	Pärnu	
5	S1rk	Raikküla	
6	S1jr	Juuru	
7	O3prk-prg	Porkuni, Pirgu	Ärina, Adila, Moe
8	O3vr	Vormsi	Kõrgessaare, Tudulinna
9	O3-2nb-rk	Nabala, Rakvere	Saunja, Paekna, Rägavere, Tõrremäe
10	O2on	Oandu	Hirmuse
11	O2kl-jh-id- kk	Keila, Jõhvi, Idavere, Kukruse	Kahula 2 ja Kahula 1
12	O2kk	Kukruse põlevkivi	
13	O2uh	Uhaku	Kõrgekalda
14	O2ls-as-kn	Lasnamäe, Aseri, Kunda	
15	O1-tl-lt-vr	Toila-Leetse, Latorpi, Volhovi, Varangu, Türisalu	Kalvi, Künnapõhja, Saka, Mäeküla, Joa, Klooga
16	O1pk-Ca1pr	Pakerordi, Pirita	Kallavere, Tsitre, Ülgase, Tiskre, Rannamõisa, Kakumäe
17	Ca1k-ln	Lücati, Lontova	Tammeneeme, Kestla, Mahu, Sämi
18	V2vr	Voronka	Kannuka, Sirgala
19	V2kt	Kötkin	Kroodi
20	V2gd	Gdov	Uusküla, Moldova, Oru



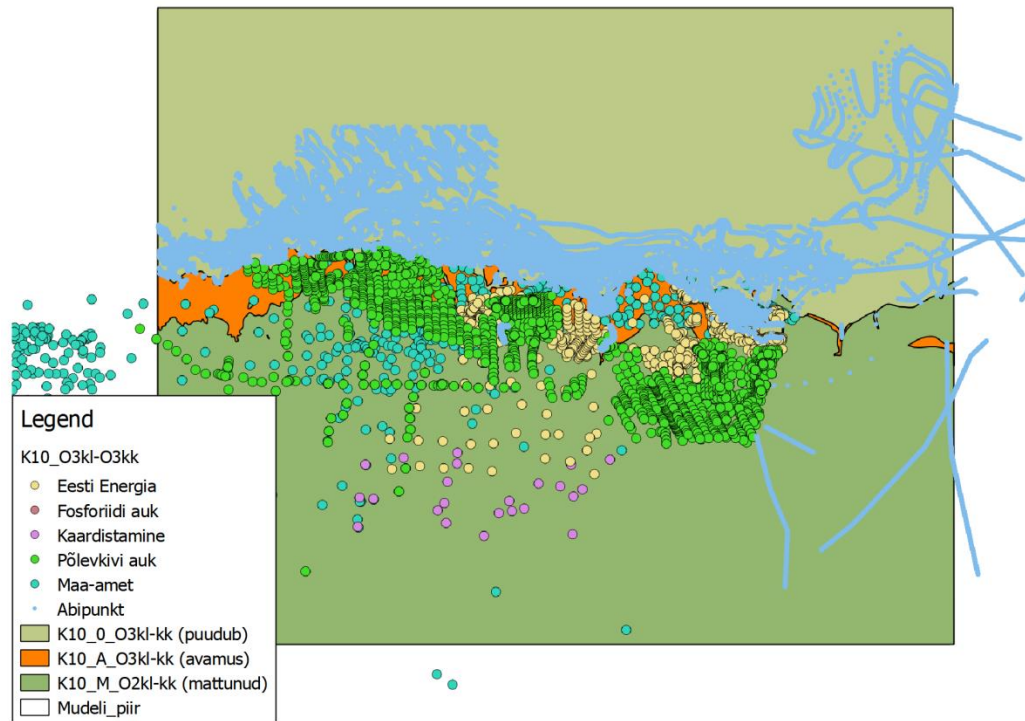
## Pindade loomine

Iga mudelis oleva kihi ülemise piirpinna jaoks on eraldi punktandmete shp fail (20 tk).

Iga andmepunkti küljes on viiteid algallikale (Pa nr, EGF, kõide)

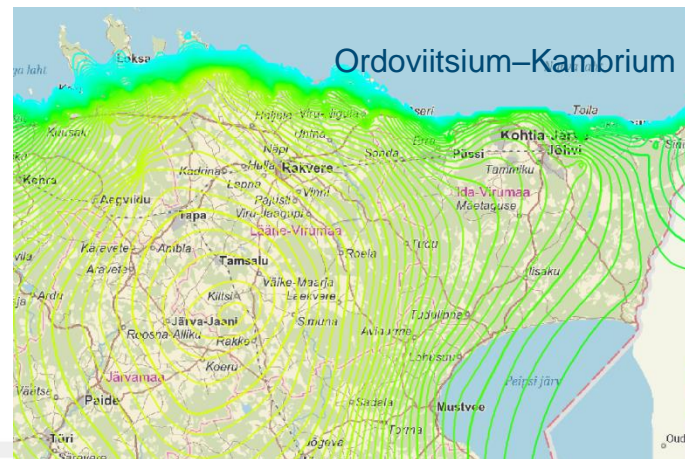
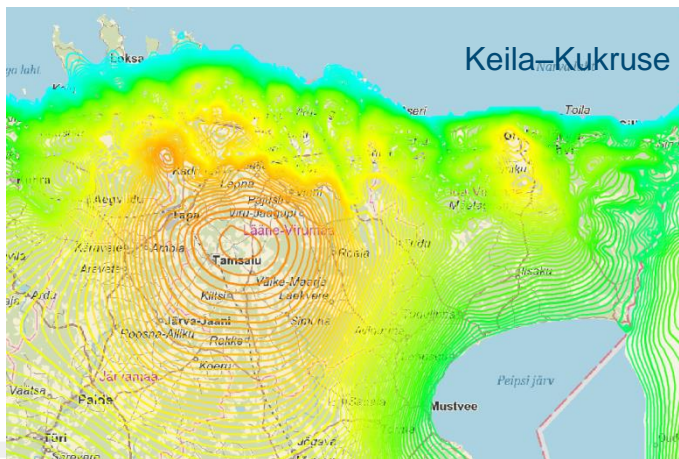
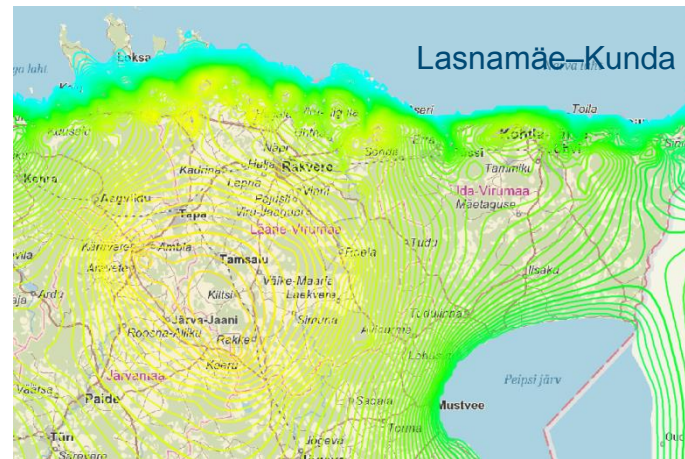
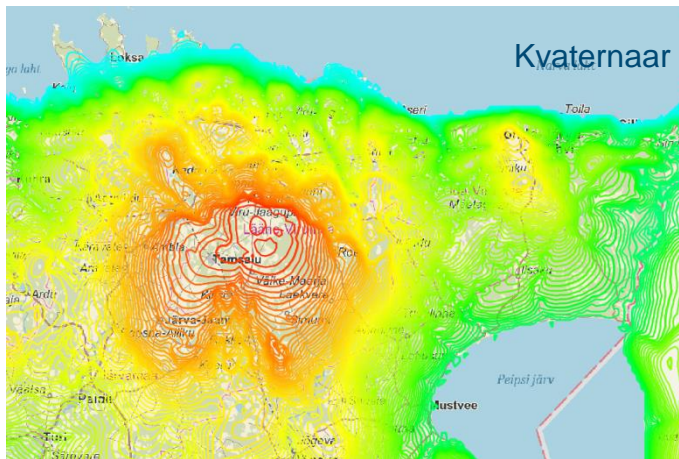
Seal, kus kiht puudub kasutatakse aluspõhja pealispinna punkte.

NB! ModFlow eeldab, et pind on üle mudeli ala pidev.



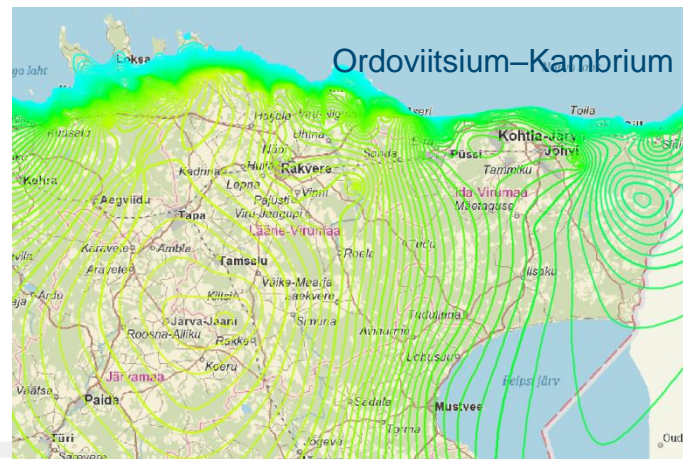
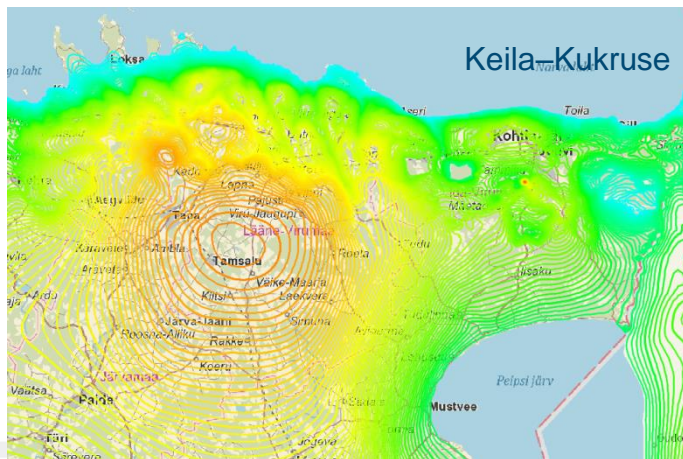
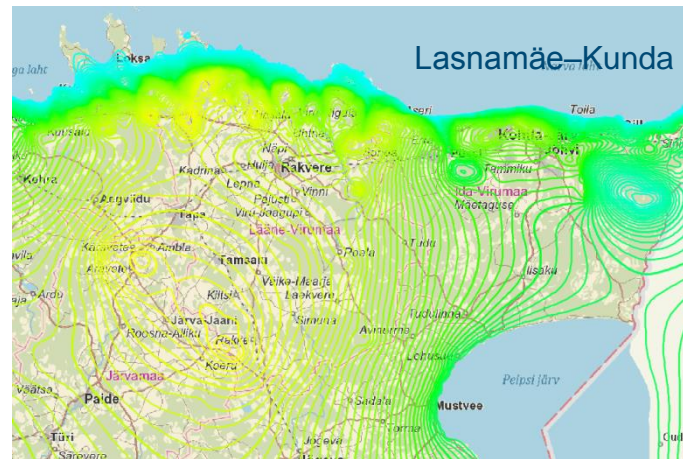
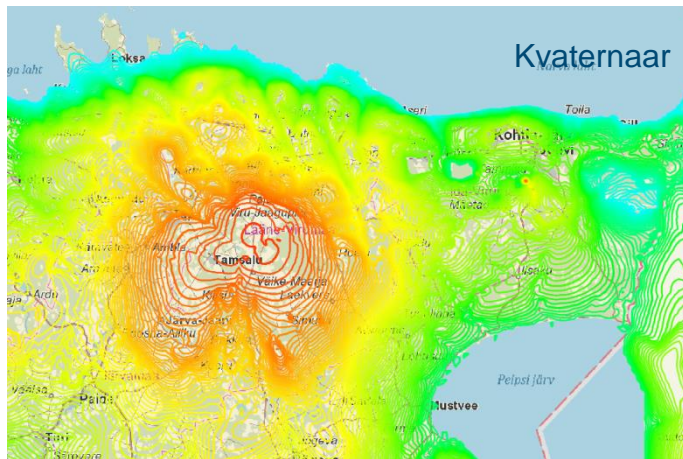


1954





2016

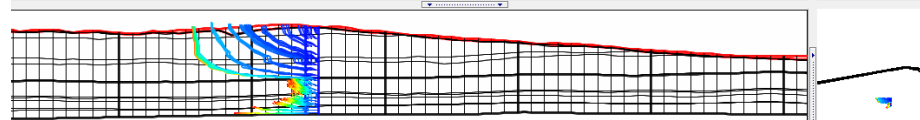
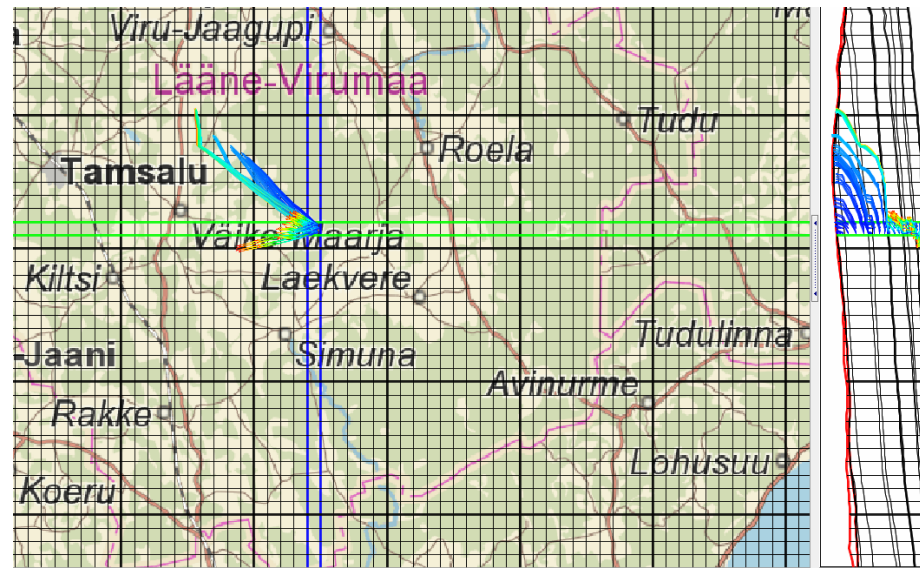
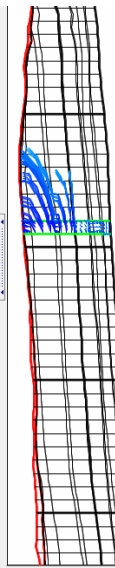




# Kust vesi tuli?

500 aastat tagasi

5000 aastat tagasi



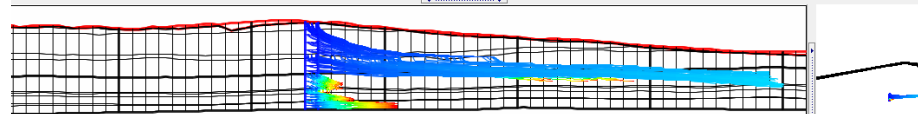
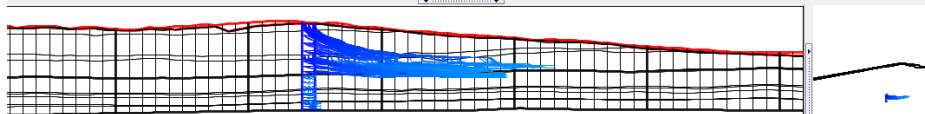
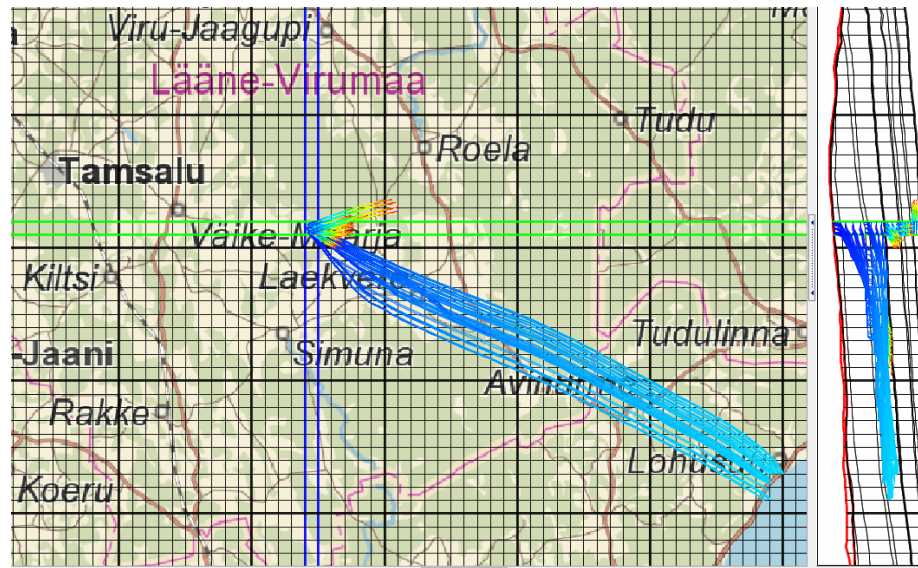
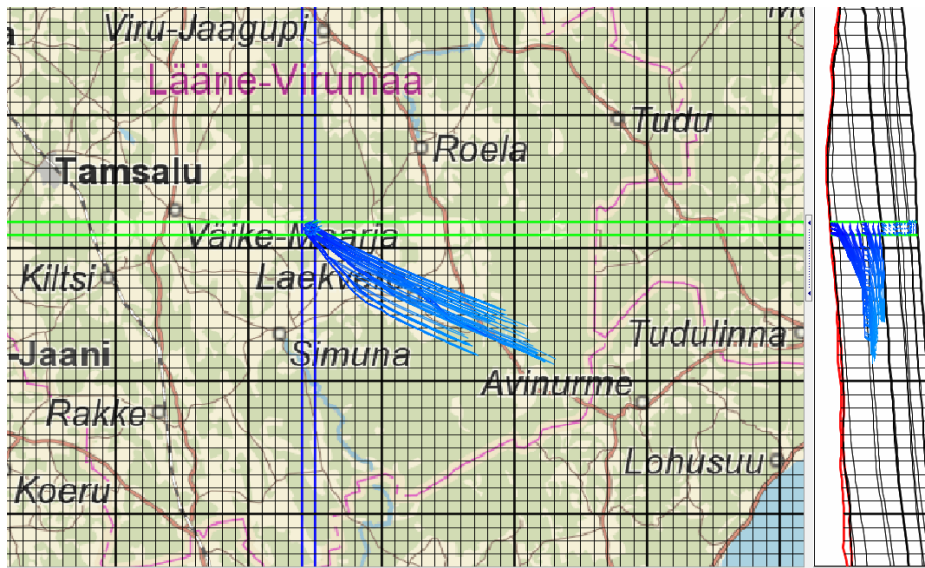




# Kuhu vesi läheb?

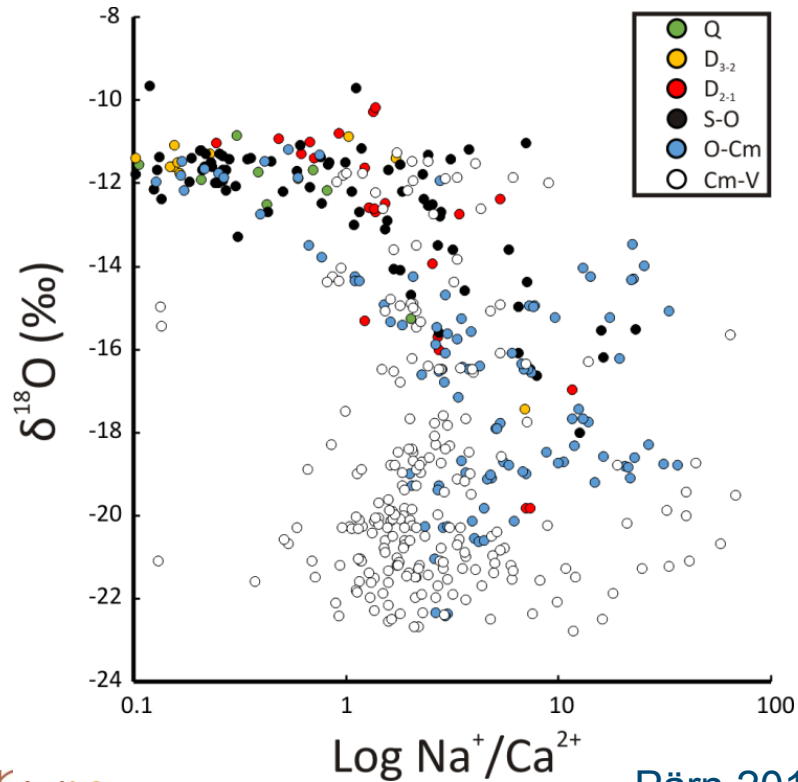
500 aastat edasi

5000 aastat edasi





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20	V2gd	Gdov	Uusküla, Moldova, Oru



## Isotoopuuringud näitavad, et liustiku sulavesi on Põhja-Eestis

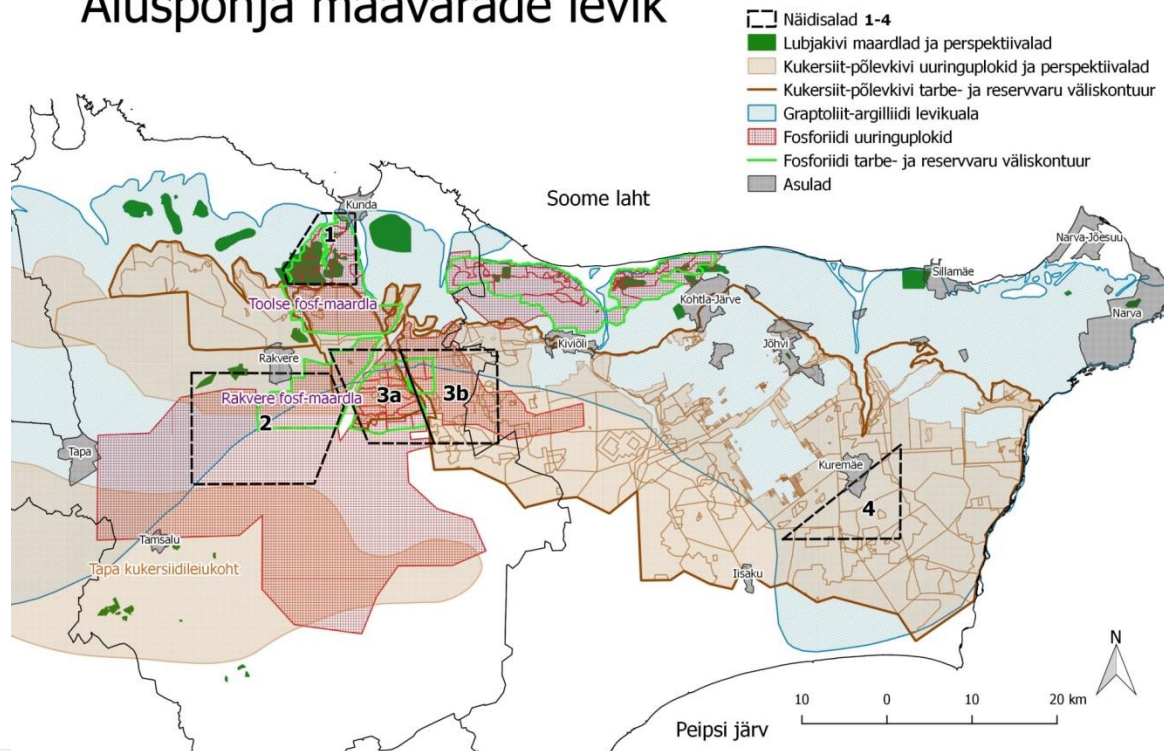
- O–Cm veekiht, kui kiht sügavamal kui 30 m
- O kivimites sügavusel >70 ... >100 m

Pärn 2018



# Virtuaalsed fosforiidi kaevandused

## Aluspõhja maavarade levik





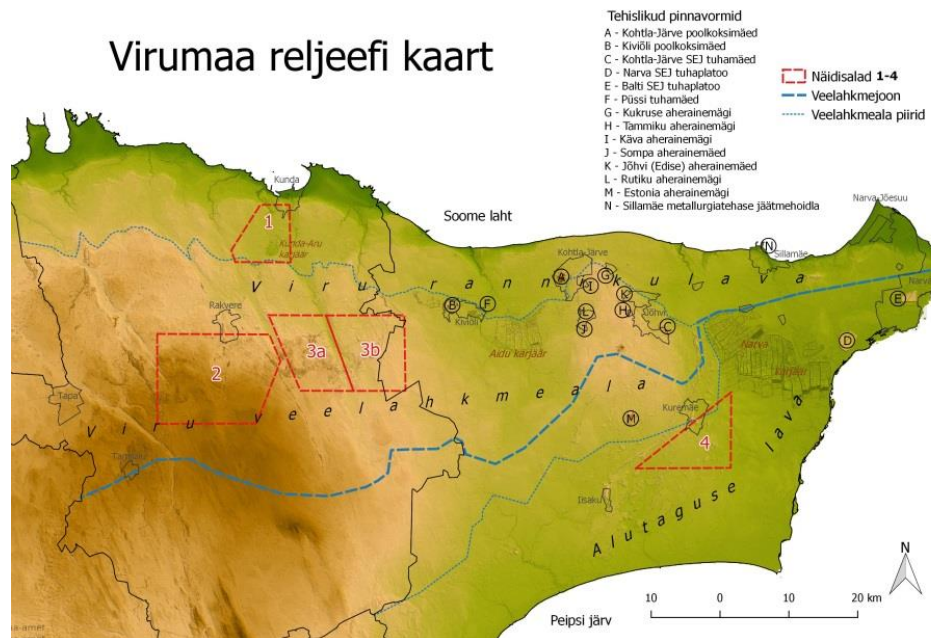
# Näidisalad

Fosforiidi puhul alad  
Pandivere võlvil, nõlval, jalamil

Nädisala piires maavara  
käsitletav ühesuguste  
omadustega

Piirid maastikulise liigestuse  
järgi

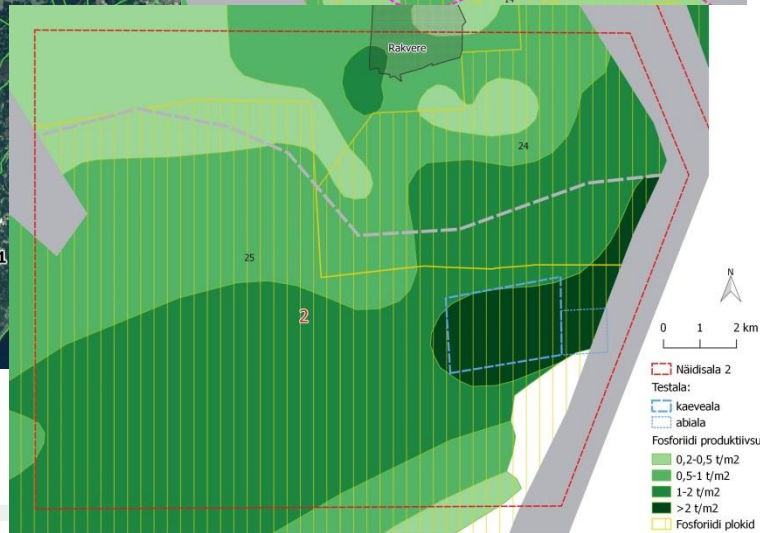
Virumaa reljeefi kaart



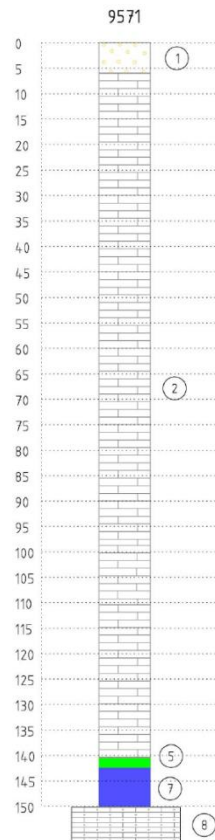
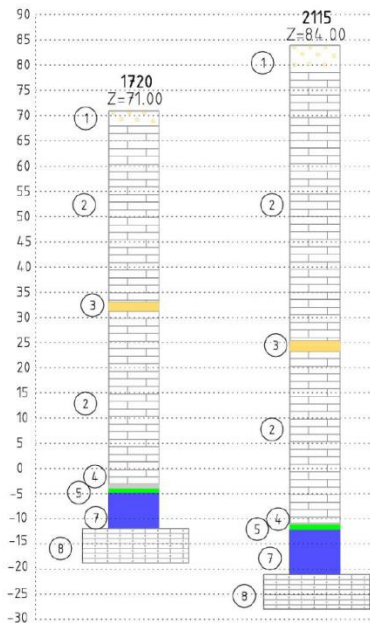
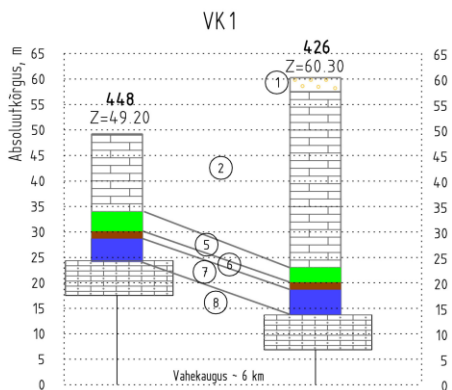


# Testalad

Testalade  
mõõdud vastavad  
ca. 30 aasta  
kaevandusmahule



Ei projekteerita  
tegelikke  
kaevandusi!

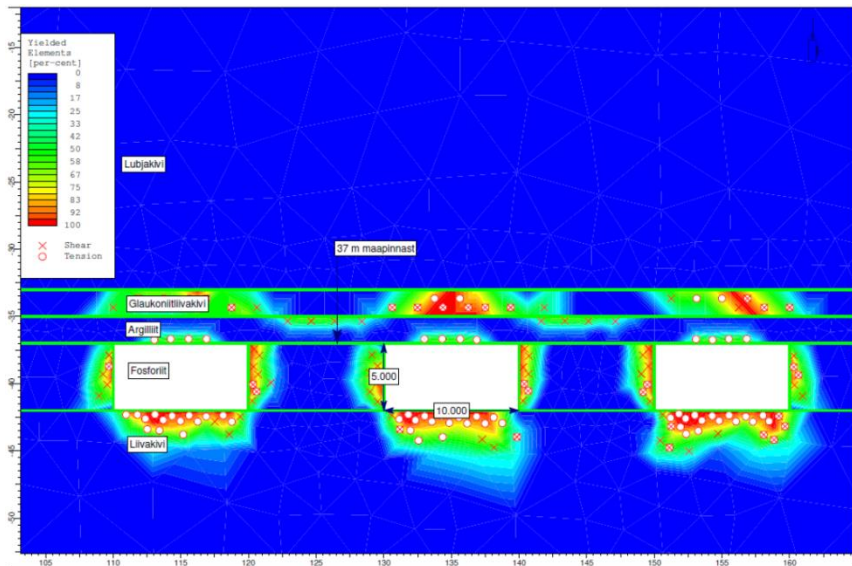


IMM

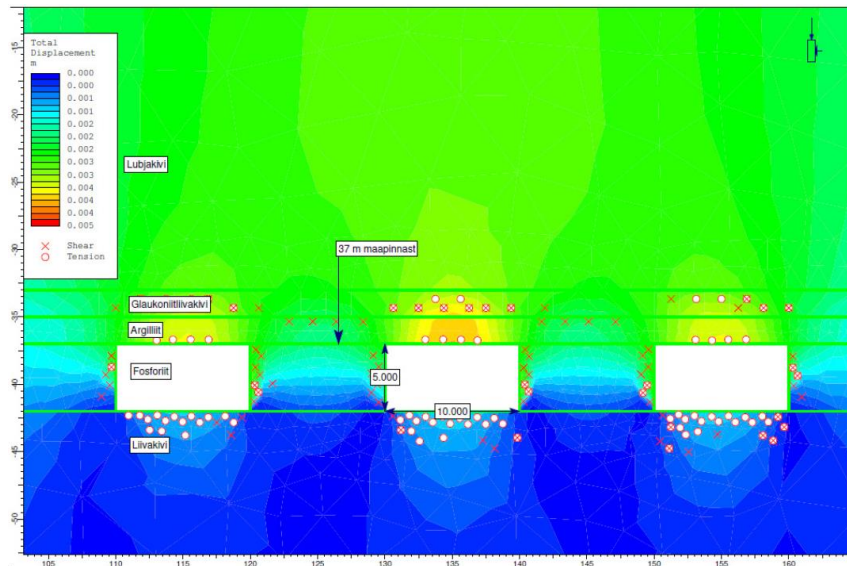
**JAINVESTEEINGUTE KESKUS**



# Kaevandustingimuste analüüs



Purustused

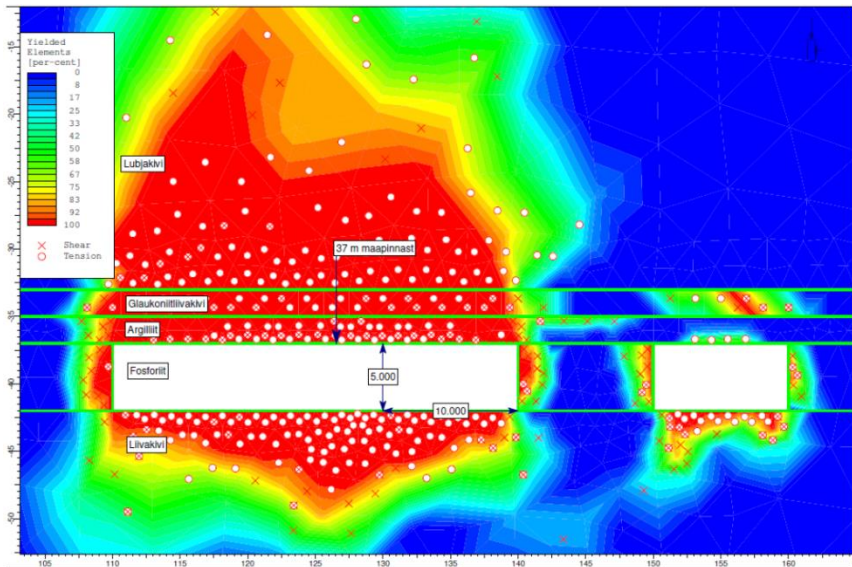


Nihked

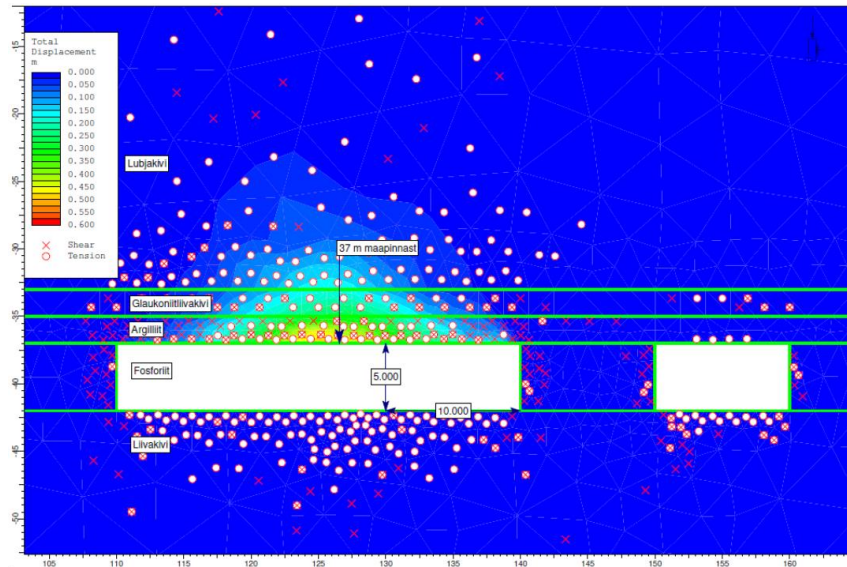




# Tooitse



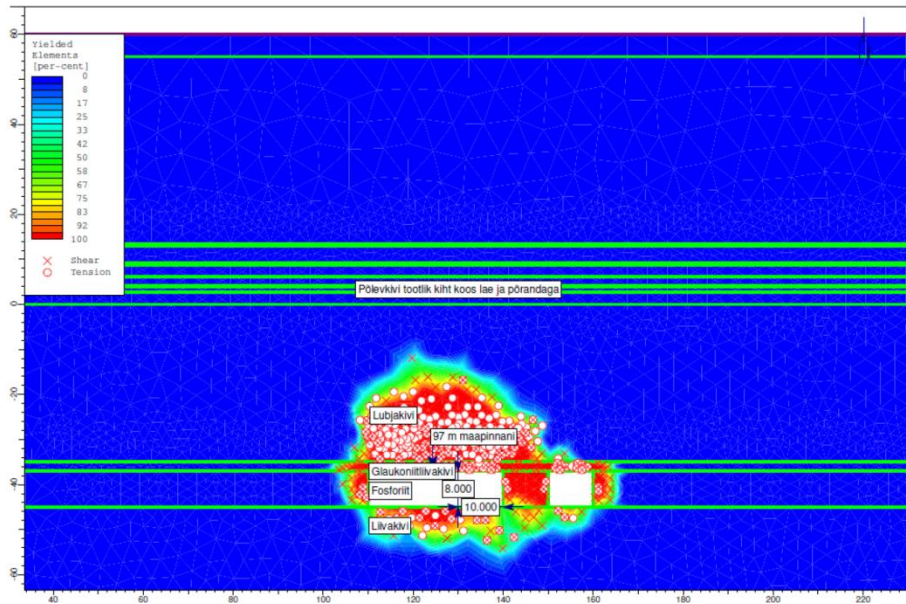
## Purustused



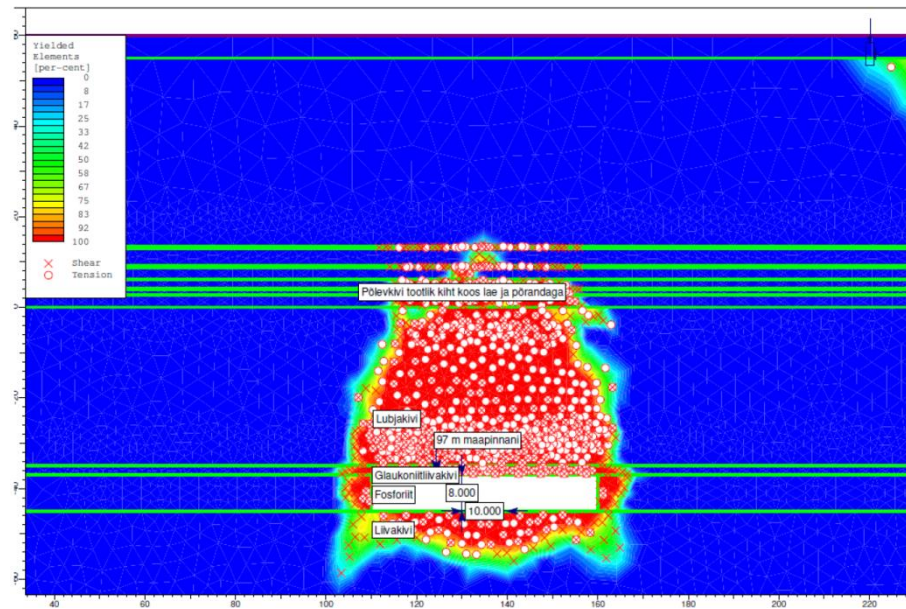
## Nihked



# Kabala



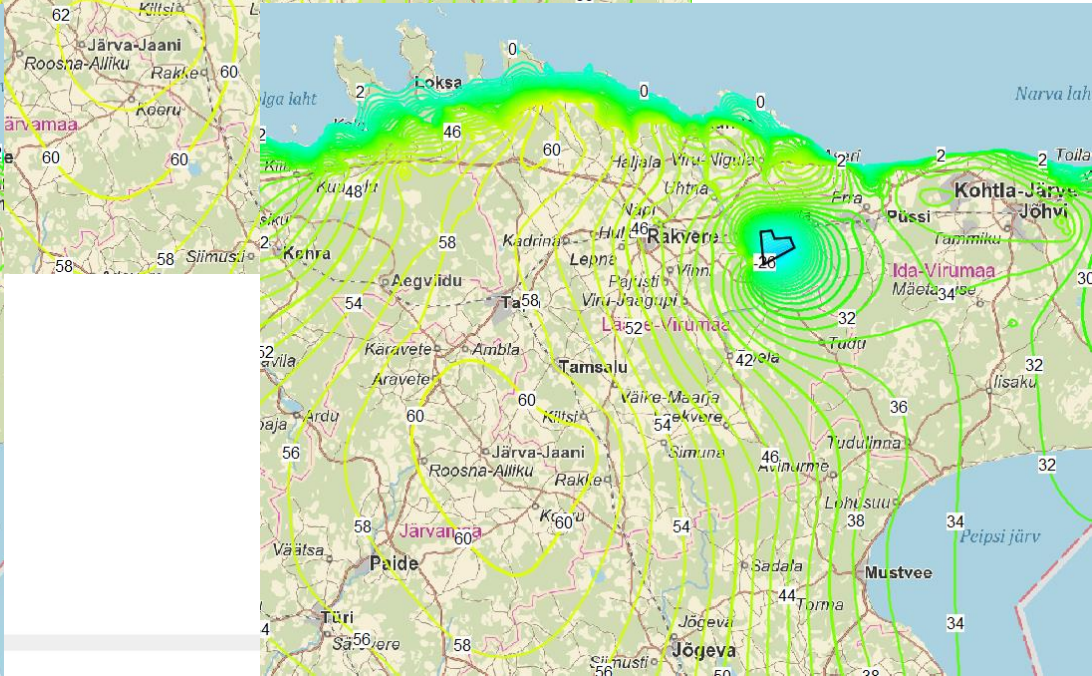
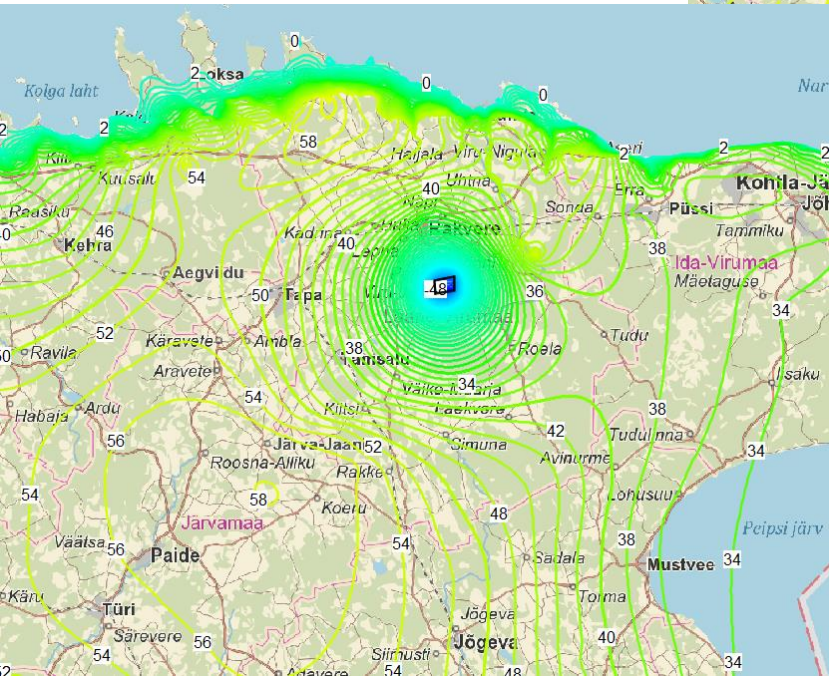
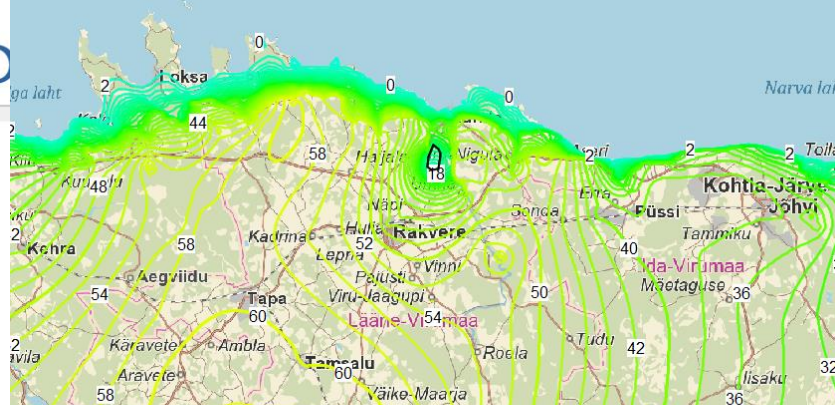
kaeveõõs 30 m laiune



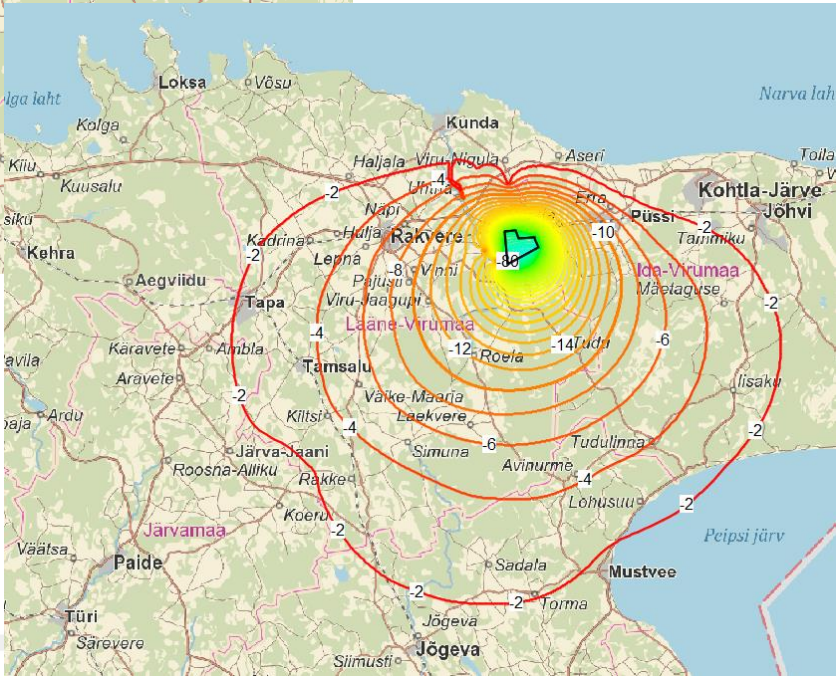
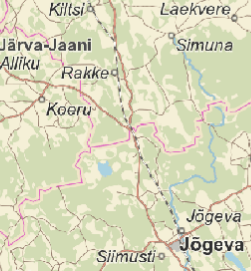
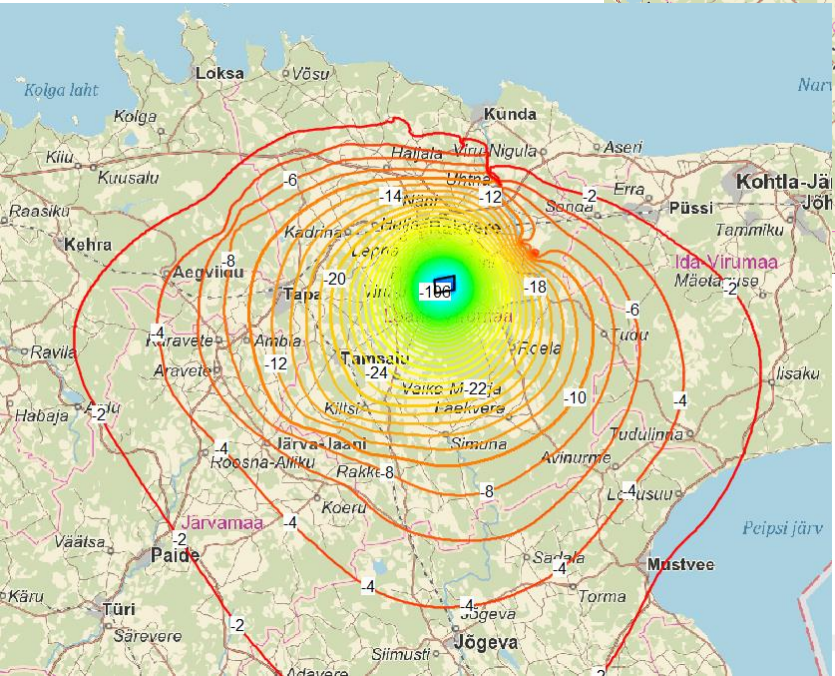
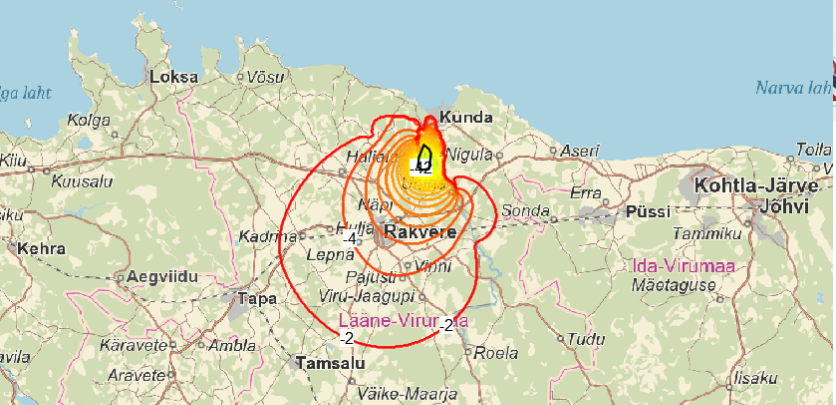
kaeveõõs 50 m laiune



# Veetase 0–Cm veekihis



# Taseme alandus 0–Cm veeühis

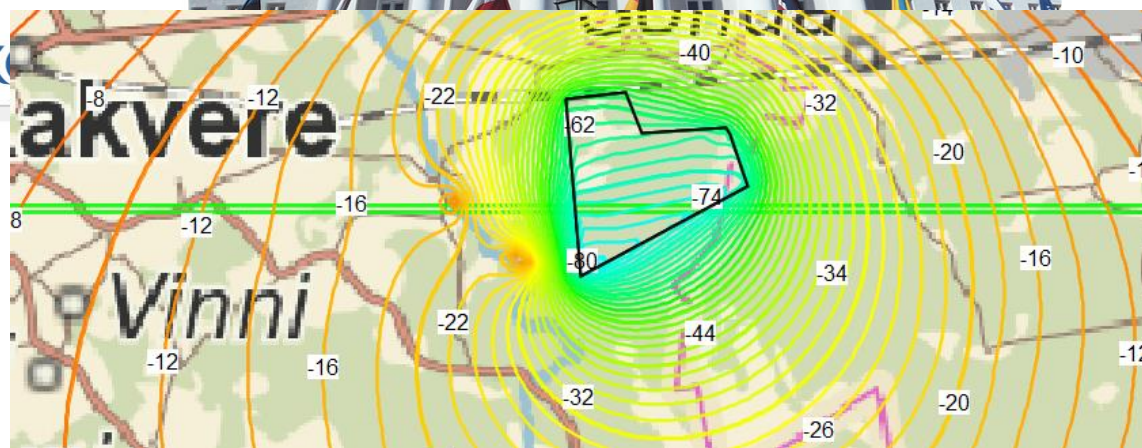




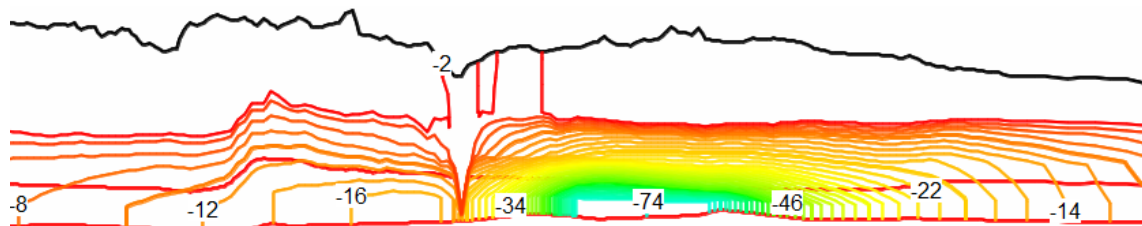
## Tähelepanekud

- Alanduslehtri välja kujunemine ja täitumine väga kiire
- Kunda oru geoloogiline ehitus vajab täpsustamist
- Alanduslehter peamiselt O–Cm ja O<sub>1</sub>ls-kn veekihtides; kõrgemates kihtides siis, kui vertikaalne veejuhtivus kasvab kaks suurusjärku või rohkem

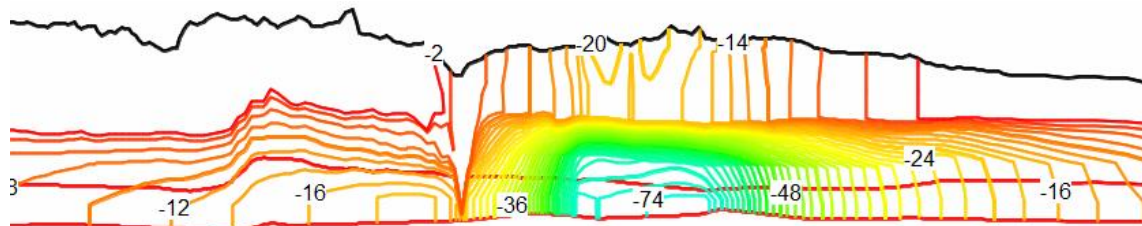
Veetaseme  
alanemine  
O–Cm  
veekihis



Vertikaalne  
veejuhtivus  
katendis säilib

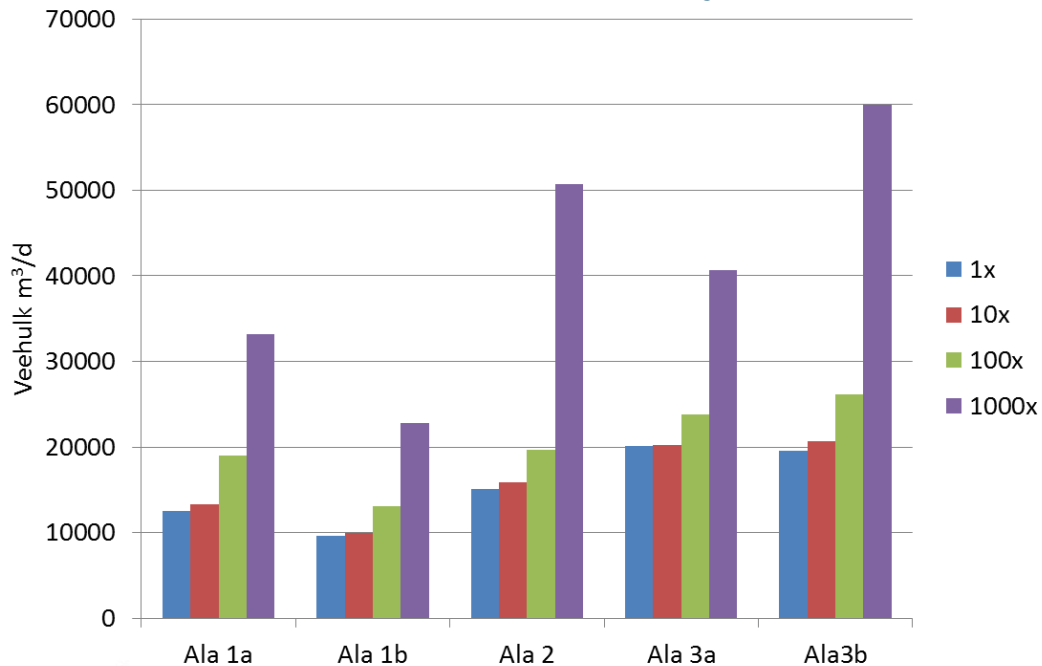


Vertikaalne  
veejuhtivus katendis  
kasvab 1000x





# Väljapumbatava veehulga sõltuvus vertikaalse veejuhtivuse muutusest



Veepidemete vertikaalse veejuhtivuse kasv 2 suurusjärku või rohkem põhjustab veetaseme alanemist lasuvates kihtides

- > kiirem veevahetus
- > sulfaadid
- > veekihtide segunemine



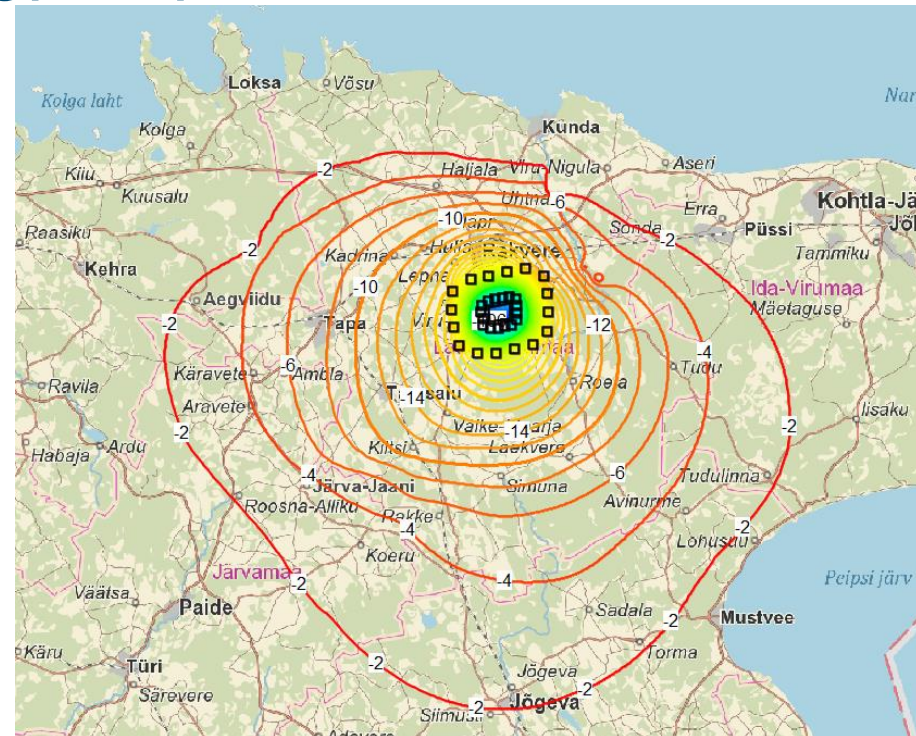
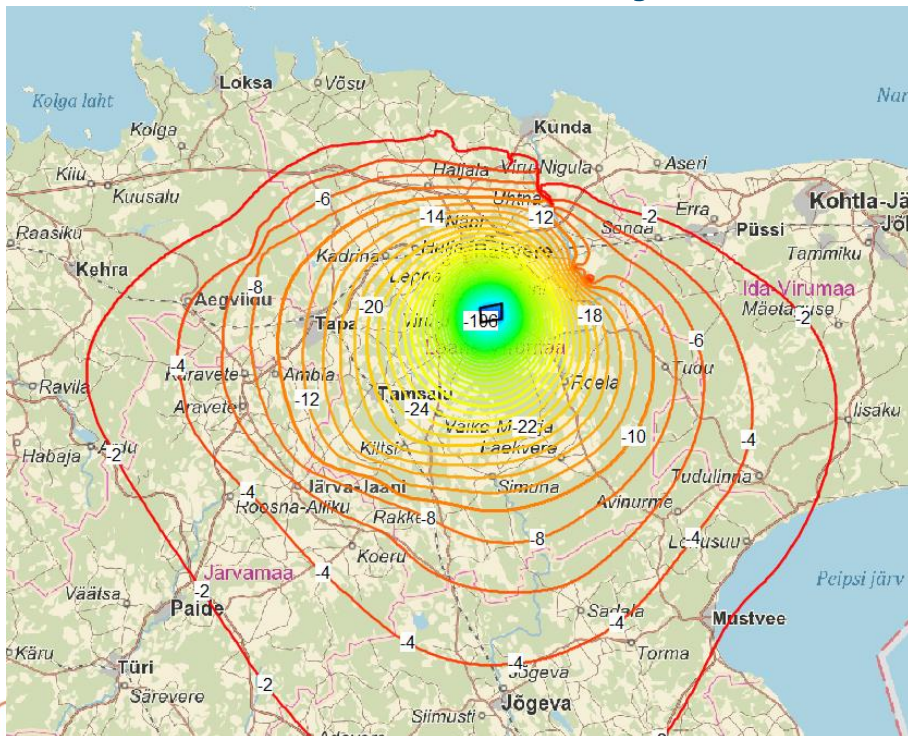
## Leevendusmeetmed

- Tagasitaitmine
- Vee ringpumpamine



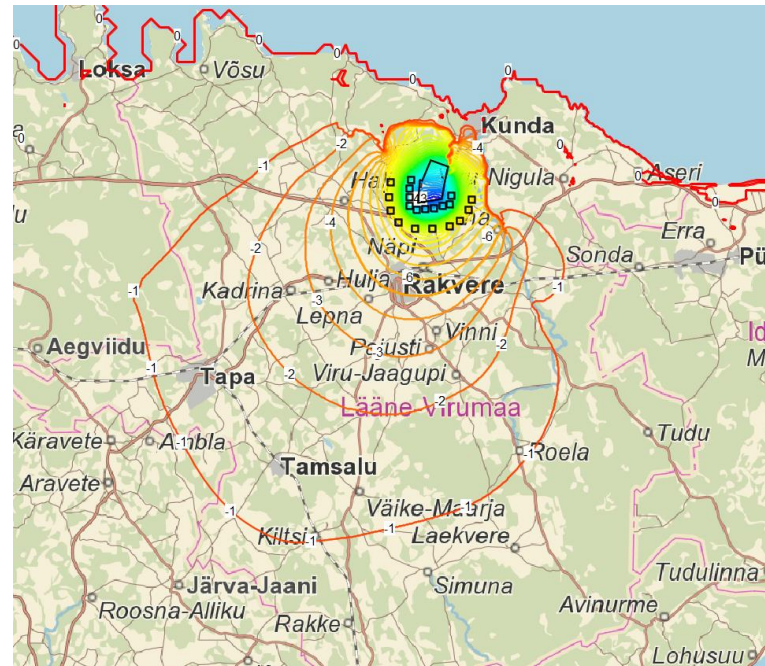
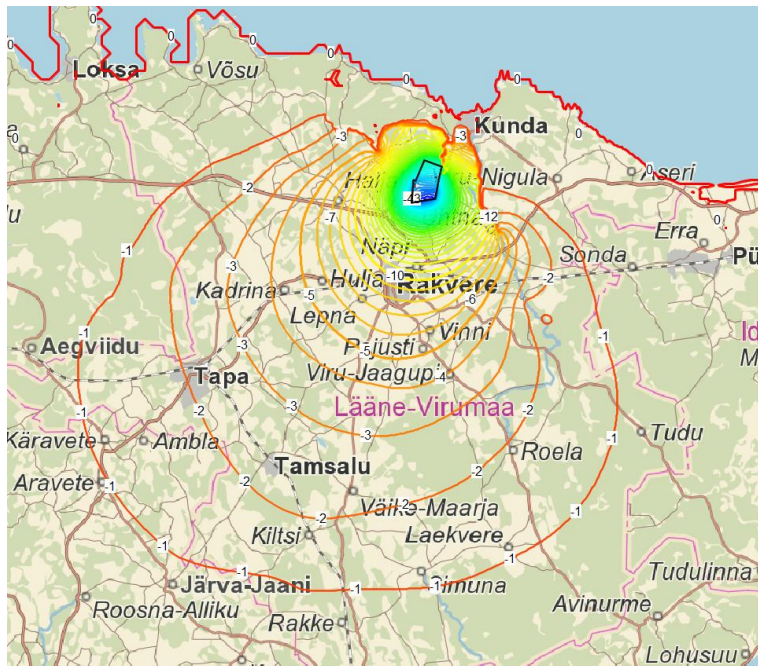


# Põhjavee ringpumpamine



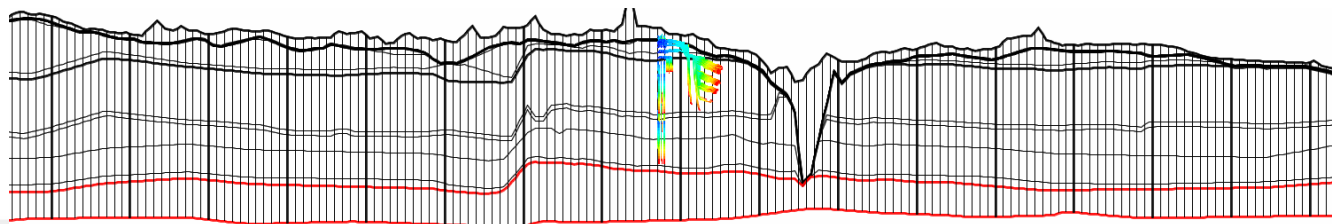
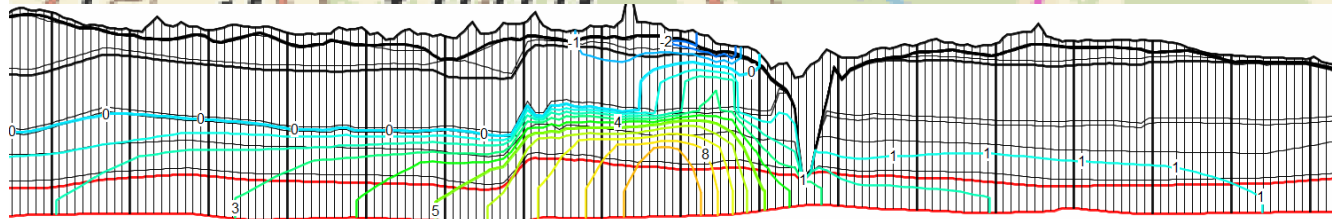
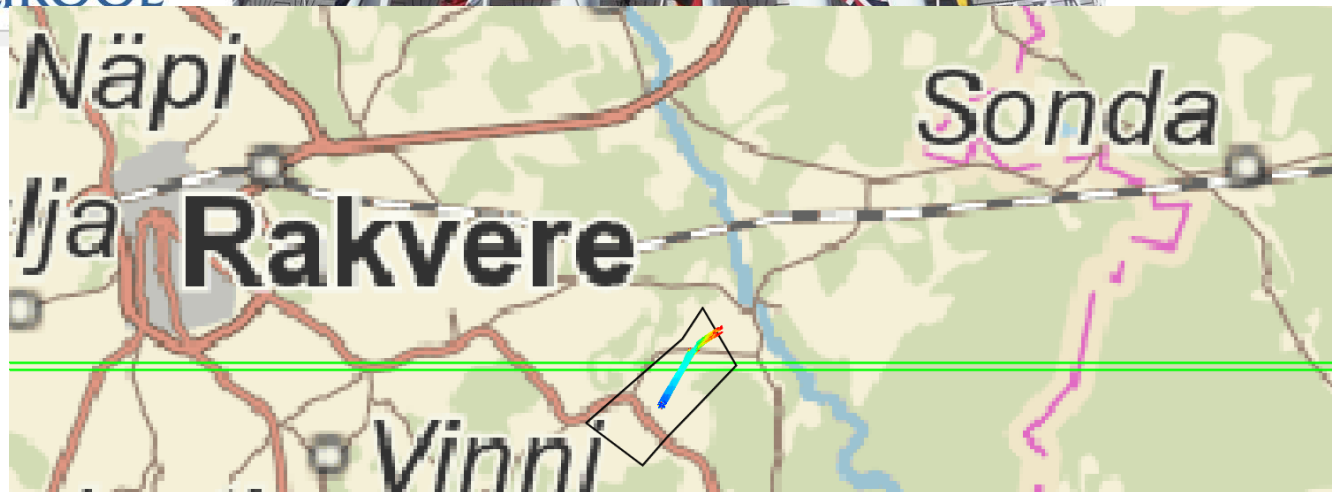


# Põhjavee ringpumpamine





Mis saab pärast  
kaevanduse  
sulgemist?





# Täna kuulamast!