SUSTAINABLE GROUNDWATER MONITORING SYSTEM OF EAST-VIRU COUNTY, ESTONIA

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Development of the regional groundwater model including impact of oil shale mining to water levels and sulphate contamination (Intermediate report 4)

2010

1. Introduction

The activity 4 “Development of the regional groundwater model including impact of oil shale mining to water levels and sulphate contamination” is one of the most important activities. Within the WFD references to risk is the concept that we are assessing the impact of human activity on the environment and specifically those impacts that treaten our ability to meet the objectives of the WFD (as set out in Article 4).

Article 4 contains five objectives for groundwater what are actual in East-Viru County too:

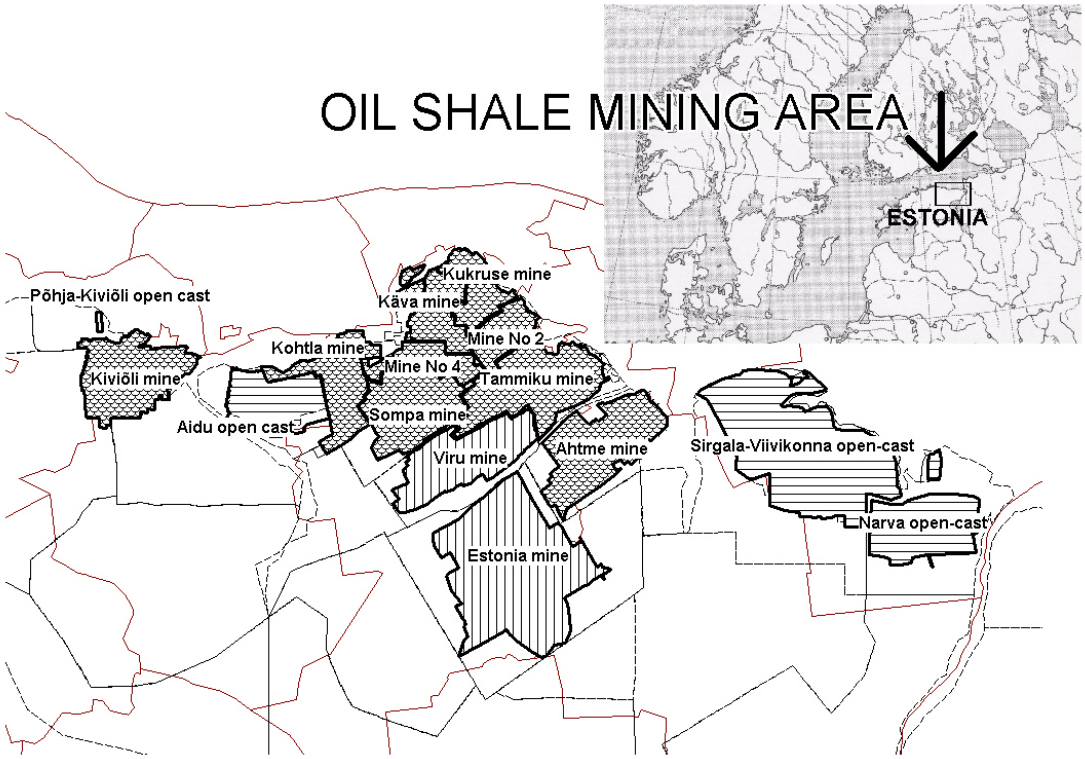
1. Prevent or limit the input of pollutants.
2. Prevent the deterioration of status of groundwater bodies.
3. Achieve good groundwater status (both chemical and quantitative).
4. Implement measures to reverse any significant and sustained upward trend.
5. Meet the requirements of protected areas.

2. Formation of groundwater flow in oil shale mining area

Over the decades scientists have developed various concepts to mitigate environmental problems connected with mining and these have been partly also used in practice. Thus, large amounts of materials have been published concerning changes in the natural and man-made environment due to oil shale mining in North-East Estonia. The importance of these publications is wider than just solution of problems connected with the Estonian oil shale basin.

Oil shale mining is accompanied by the lowering of the water level and discharge of mine water into bodies of surface water. The total amount of drained water is formed from precipitation water, surface water, subsoil water (unconfined groundwater) and confined groundwater, and mine water is actually part of the natural cycle of water; the components of the balance of water pumped out from open-casts and underground mines differ significantly.

In the southern part of the Estonian mine and Narva open-cast (Figure 1) the Keila-Kukruse aquifer is confined (layers that are well isolated from recharge by precipitation. To calculate the balance of mine water inflow, results of groundwater monitoring and mine water inflow data as well as hydrogeological modelling were used. The hydrogeological model used was developed by the hydrogeologists L. Savitski and V. Savva from the Geological Survey of Estonia for the central part of the Estonian oil shale field and Aidu open-cast (Savitski, Savva. (2001)**.** In the case of Narva open-cast, which consists of Viivikonna, Sirgala and Narva open-cast fields, analytical solutions based on hydrodynamic equations were used to estimate the groundwater component.



The area of the mines flooded and becoming filled with water is presently over 220 km², the volume of water in these mines is more than 170 mln m³. On the basis of the results of the solution to the hydrological model developed at the Geological Survey of Estonia it was found that the inflow from closed flooded mines to the Viru mine amounts to 26 000 m³ a day or 45% of the total inflow and the inflow of unconfined groundwater makes up 55% (Table 1).

Although the Estonia mine is located at a much greater depth than the Viru mine, the long-term dynamics of the inflow to the latter mine also shows rather great dependence on weather conditions. This is evidenced by the factor of irregularity of the monthly inflow, which fluctuates in the range 2.0–3.3.

Table 1.

Distribution of water pumped out from underground and open-cast oil shale mines, %

Mine	Groundwater, %			Inflow from flooded mines	Water infiltrating back from outflow canals	Precipitation water	Water drained in 2004, m³/d
	Unconfined	Confined	Total				
Viru underground mine	55	-	55	45	-	-	56543
Estonia underground mine	47	26	73	20	7	-	208018
Total underground mines	**51**	**13**	**64**	**32,5**	**3,5**	**-**	**264561**
Narva open-cast mine, Narva department	10	10	20	-	-	80	55032
Sirgala department	6	10	16	-	-	84	83765
Viivikonna department	34	-	34	-	-	66	51144
Aidu open-cast mine	27	-	27	54	-	19	168736
Total open-cast mines	**19.25**	**5**	**24.25**	**13.5**	**-**	**62.25**	**358677**

In the Estonian oil shale field the operating units are presently Aidu open-cast mine and its Vanaküla department; Narva open-cast mine, which consists of Narva, Sirgala and Viivikonna open-cast fields and Põhja-Kiviõli open-cast mine). Calculations of the components of the inflow balance of open-cast mine fields are presented in Table 1. It can be seen that confined groundwater makes up 10% of the total inflow, the proportion of unconfined groundwater in different open-cast mine fields accounts for 6–34% and precipitation water makes up 66–84% in the depleted area (Perens et al, 2006).

3. Groundwater pollution

Once polluted, groundwater is extremely difficult to clean up owing to its inaccessibility, its huge volume and its slow flow rates. The three major pollution threats are urbanisation., industrial activities and agriculture.

Pollution impacts are distinguished related to either human uses or the environment. In the first instance, pollutants found in groundwater are listed according to their toxic impacts on

drinking water quality according to for example, WHO drinking water quality guidelines or EU legislation (Drinking Water Directive).

Pollutants may also be distinguished according to their ecotoxicological impacts, i. e. substances, which are detrimental to the environment such as those pollutants listed in EU Water Framework Directive. This distinction is important in that the "pollution impact" should be assessed differently whether it is related to a particular use of the water resource or to an impact on the aquatic or terrestrial environment.

Due to interactions of the groundwater with the soil or surrounding rocks groundwater may contain high concentrations naturally and which as such does not correspond to the pollution, but which may hamper the use of the groundwater for drinking water abstraction. Usually this does not mean, however, that the groundwater is of "bad environmental quality".

Although the oxidation of pyrite is the natural process, it is caused by human activity and so increased content of sulphates in groundwater of East-Viru County is correctly named as pollution.

4. Sources of sulphate contamination

Previous studies indicate that groundwater inflowing to the mines has high sulphate concentrations due to oxidation of pyrite disseminated in the limestones or occurring as pyrite seams with close association with the oil shale. Oxidation and weathering of sulphides is also ongoing in tailing dumps of oil shale mines. Discharges of sulphate containing mining waters into the Purtse River have been found to have negative impacts on the phytoplankton (Rätsep and Liblik, 2000). Closure of some oil shale mines have been reported to have catchment scale impacts on hydrology including regional scale increases on sulphate concentrations in despite of the of the reduction of mine discharges to the rivers (Rätsep and Liblik, 2000; Erg, 2005). Long-term research conducted in the neighbouring Kurtna Nature Reserve, where on the basis of some likes systems for directing pumped-out mine water have been established, shows that compared to 1937 the concentration of sulphates in through-flowing lakes has increased tens of times (Punning, 1994).

A quantitative determination of iron sulphide weathering is a complex problem because weathering can involve both geochemical and biochemical components (Sober at all, 1987). The geochemical oxidation of pyrite may be characterized by the following reactions:

$$Fe\,S_2 + 7/2\,O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+ \quad (1)$$

$$Fe^{2+} + ¼\,O_2 + H+ = Fe^{3+} + ½\,H_2O \quad (2)$$

$$Fe^{3+} + 3H_2O = Fe\,(OH)_3 + 3H^+ \quad (3)$$

$$FeS_2 + 14Fe^{3+} + 8H_2O = 15Fe^{2+} + 2SO_4^{2-} + 16H^+ \quad (4)$$

After pyrite is oxidized (equation), ferric Fe is produced extremely slowly (equation 2). This second reaction, however, can be accelerated by microbial catalysis to increase the overall rate of the oxidation of ferrous Fe (4).

Oxidation of sulphide minerals and in general, weathering reactions of minerals in limestones and oil shale layers will also release to the environment also heavy metals. The calcite rich Ordovician limestone are capable to buffer efficiently pH in levels where many heavy metals are efficiently fixed by sorption to ferrous hydroxides and maintain high bicarbonate concentrations.

6. Groundwater quality background levels and sulphate concentration of groundwater in pre-mining time

The terms background, threshold and baseline quality values have been classically used to try to identify anomalous concentrations with respect to what are considered as “typical” values. These values are critical to define water quality for a given use, and have to be defined for groundwater as a guide for protection and remediation programmes.

The baseline chemical composition or baseline quality of a groundwater body may be defined, quite instinctively, as the physicochemical conditions due only to natural processes during recharge, flow and water-rock interaction. Should this be possible, any impact on groundwater quality could easily be shown by comparing actual values to baseline values. It is necessary to know whether a given concentration is natural, the result of hydrologic changes due to human activities or the result of introducing substances from outside into the groundwater body.

Any adverse change in physicochemical properties is called contamination, and the substances producing this change are called contaminants. If these substances are artificially introduced in some way they can be called pollutants, and the result is pollution. These are the definitions that are used in an International Overview “Groundwater Science and Policy” (Quevanviller, 2008).

To establish the baseline quality of an aquifer or groundwater body, the ideal situation is when available chemical data correspond reasonably well to areas unaffected by human activity. In East-Viru County by oil shale mining activity the Ordovician aquifer system is divided by two groundwater body: Ordovician East-Viru GWB and Ordovician East-Viru Oil Shale Basin GWB. Differences in chemical composition of groundwater bodies are induced mainly by oil shale mining activity. For that reason characteristics of chemical composition of groundwater of the Ordovician East-Viru GWB may treat with baseline quality criterion (Table 1). The most differences in chemical composition are in concentrations of sulphates and in values of total hardness and dry

Table 2. The characteristics of chemical composition of groundwater of the Ordovician East-Viru GWB

	Na, mg/l	*K, mg/l*	*Na+K, mg/l*	*NH4, mg/l*	*Ca, mg/l*	*Mg, mg/l*	*Fe2, mg/l*	*Fe total, mg/l*	*Cl, mg/l*	*SO4, mg/l*	*NO3, mg/l*	*NO2, mg/l*	*CO3, mg/l*	*HCO3, mg/l*	*Hardness, mg-ekv*	*pH*	*SiO2, mg/l*	*CO2 free, mg/l*	*COD, mgO2/l*	*Dry residue (TDS), mg/l*
Mean 2004	25.1	6.0	31.1	1.66	39.8	15.7	4.03	4.56	30.3	8.7	0.7	0.025	8.0	229.2	3.5	7.6	8.3	27.6	2.8	266.5
Mean 2005	24.9	6.1	31.0	1.63	45.3	17.6	5.56	5.80	27.9	13.4	0.7	0.014	9.0	238.8	4.0	7.5	7.7	21.8	5.2	282.4
Mean 2006	26.3	5.4	31.7	0.66	48.0	15.8	4.34	4.41	33.6	13.9	1.3	0.042	7.4	238.8	3.7	7.7	7.6	17.6	4.0	297.8
Mean 2007	24.4	6.9	31.3	1.12	52.5	20.8	2.90	2.96	38.8	7.6	1.5	0.075		284.1	4.3	7.6	7.4	15.7	5.0	318.9
Mean 2008	26.2	7.0	33.2	0.55	50.2	20.5	4.11	4.14	31.6	7.9	3.0	0.118	6.9	285.0	4.2	7.4	8.3	11.9	5.9	320.7
Mean 2009	20.7	6.8	27.5	0.63	63.1	22.4	4.45	4.62	31.6	19.3	1.1	0.029	6.0	308.1	5.0	7.4	10.5	27.5	6.6	351.9
Permitted values in drinking water	200.0			0.50				0.20	250.0	250.0	50.0	0.500				≥6,5-≤9,5			5.0	

Table 3. The characteristics of chemical composition of groundwater of the Ordovician East-Viru oil shale basin GWB

	Na, mg/l	*K, mg/l*	*Na+K, mg/l*	*NH4, mg/l*	*Ca, mg/l*	*Mg, mg/l*	*Fe2, mg/l*	*Fe total, mg/l*	*Cl, mg/l*	*SO4, mg/l*	*NO3, mg/l*	*NO2, mg/l*	*CO3, mg/l*	*HCO3, mg/l*	*Hardness, mg-ekv*	*pH*	*SiO2, mg/l*	*CO2 free, mg/l*	*COD, mgO2/l*	*Dry residue (TDS), mg/l*
Mean 2004	8.2	3.8	11.9	0.23	109.1	37.8	3.69	2.62	12.1	174.5	1.9	0.016	6.0	337.6	8.6	7.2	9.5	59.4	5.1	557.7
Mean 2005	6.9	4.3	11.1	1.09	81.4	36.0	4.29	4.86	12.4	80.9	0.4	0.004	9.0	335.6	7.0	7.5	9.5	17.6	2.7	438.8
Mean 2006	6.6	4.9	11.5	0.75	58.7	27.1	3.13	3.19	9.4	58.9	0.4	0.004	6.0	259.3	5.2	7.7	7.8	16.5	2.5	334.5
Mean 2007	15.1	8.8	23.9	0.38	112.3	34.0	1.85	1.97	40.4	146.5	0.4	0.088		328.6	8.4	7.8	7.9	31.4	4.3	599.4
Mean 2008	14.4	7.5	21.8	0.21	100.8	31.0	1.55	1.59	57.7	106.9	0.8	0.169	6.0	338.9	8.2	7.7	9.0	23.2	4.4	574.7
Mean 2009	15.6	7.8	23.4	0.54	120.6	33.7	1.05	1.07	73.5	116.8	0.4	0.106	6.0	330.1	8.8	7.8	9.3	24.6	5.4	626.3
Permitted values in drinking water	200.0			0.50				0.20	250.0	250.0	50.0	0.500				≥6,5-≤9,5			5.0	

residue (TDS) (Table 1 and 2). This is a reason that these parameters are selected for characterization of sulphate contamination process.

In areas for from mining activities the sulphate concentration in groundwater of Keuila–Kukruse and Lasnamäe–Kunda aquifers has been very low and usually didn't exceed 20 mg/l (Figures 5 and 6) what corresponds to mean concentrations of SO_4 in groundwater of the Ordovician East-Viru groundwater body (Table 1).

6. Sulphate contamination of groundwater of oil shale deposit and working mine impact on the groundwater chemistry

6.1. Keila–Kukruse aquifer

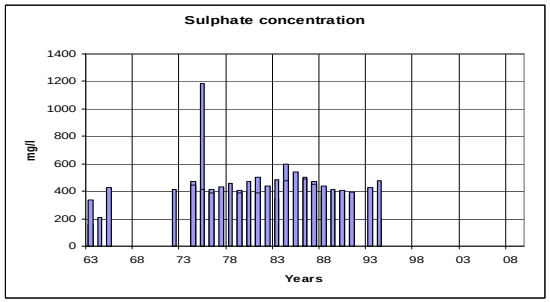
Oil shale mining started in 1916. From this time the mining has changed the groundwater regime and water chemistry. Due to mining technology, the groundwater level has lowered below the level of oil shale stratum. As result of dewatering, the groundwater level of the Keila–Kukruse aquifer was lowered by 15 m in the northern part of oil shale deposit (mines Kukruse, Käva) and 70 metres in the south (mine Estoni8a). Several local cones of depression, influencing each other formed in the middle of the 1980s. At that time the oil shale production was its highest reaching 31 million tonnes and the mine dewatering also was highest. If in the beginning 1060s, the concentration of sulphates in groundwater of Tammiku mine was 121,8 mg/l, then in 1970s it arose to 400 mg/l. During 1980s the concentration of SO_4 in groundwater of Tammiku mine decreased, but in Sompa and Ahtme mines SO_4 concentration stabilized around 400 mg/l (Figure 1).

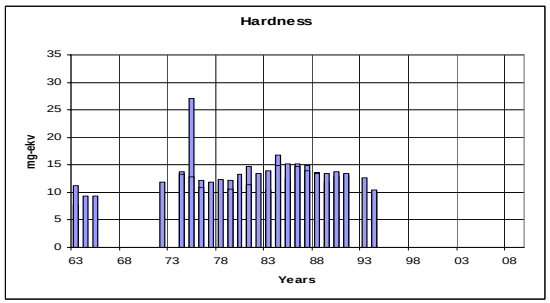
Oil shale mining in open-cast mines Sirgala and Viivikonna started in 1973, in open-cast mine Aidu in 1974. During 1970s the water inflow to open-casts increased and in 1980s stabilized at maximum amount. The changes of chemical composition have been investigated in 1980s. At this period the concentration of sulphates in groundwater of Sirgala and Aidu open-cast mines was about 600 mg/l. In the Viivikonna open-cast mine during 1980s the concentration of sulphates was more than 600 mg/l, in 1988 even 1083,1 mg/l, but at decreased to 449,8 mg/l and in beginning of 1990s the sulphates concentration was between 430–530 mg/l (Figure 2). Notable is increasing the mean concentration of sulphates at different decades from 1960 up to 2000 (Table , Figure).

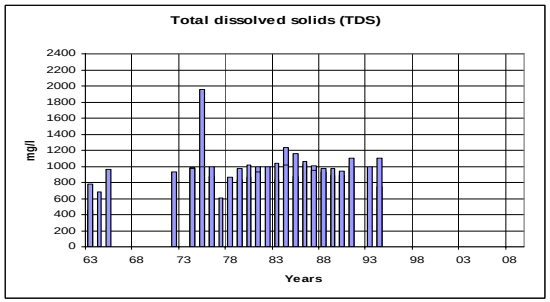
The correlation between concentration of Sulphates and total dissolved solids, also between hardness is very strong (Figures 1 and 2).

Underground mines have the potential to impact surface, but especially groundwater systems of the Keila–Kukruse stages throughout the oil shale deposit and the limestones of the Lasnamäe–Kunda stages throughout the oil shale deposit by creating new fractures and enlarging the existing ones. This typically results in detectable changes in permeability, storage capacity,

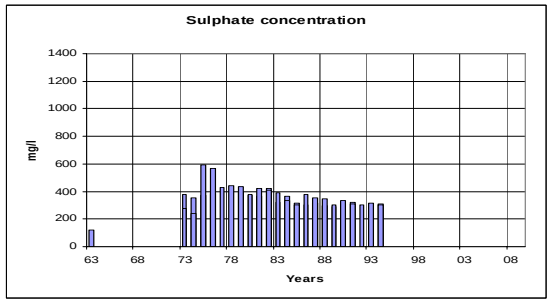
Well No. 132006 – Sompa mine

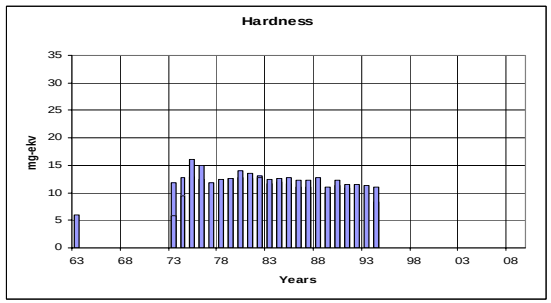


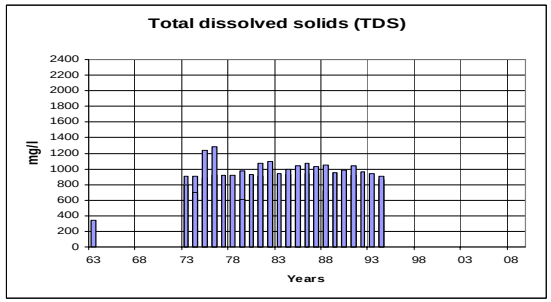




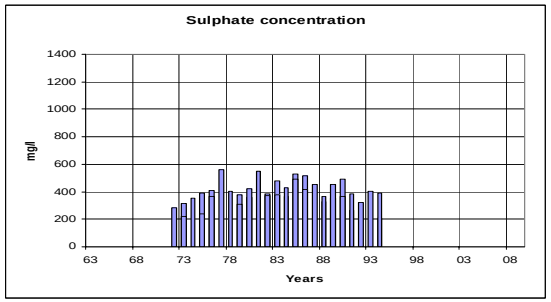
Well No. 132008 – Tammiku mine

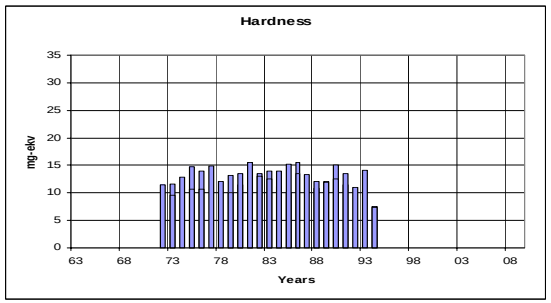


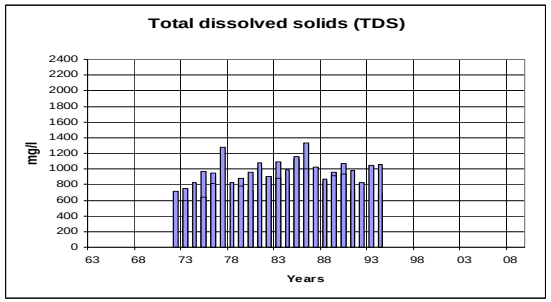




Well No. 132009 – Ahtme mine



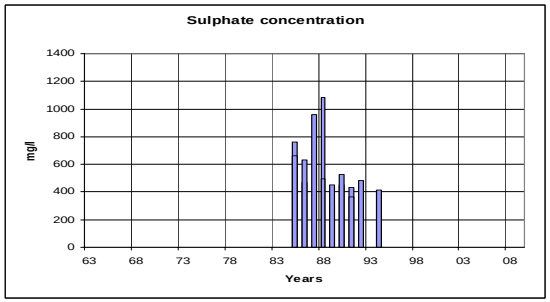


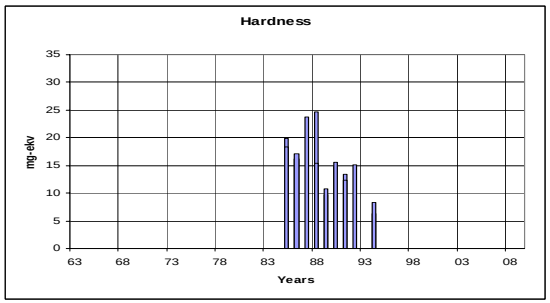


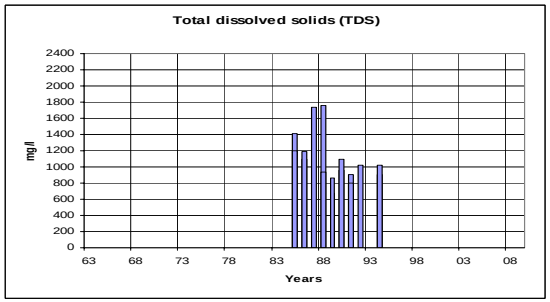
Joonis 1. Sompa, Tammiku ja Ahtme kaevanduste põhjavee sulfaatide, kareduse ja mineraalainete sisalduse muutused kaevanduste töötamise ajal.

Figure 1. Changes of concentrations of sulphates, hardness and total dissolved solids (TDS) in groundwater of Sompa, Tammiku and Ahtme mines during mining period 1963 – 1993.

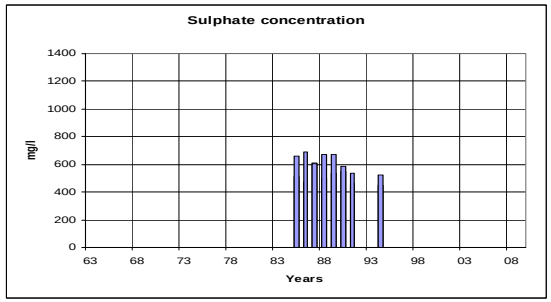
Well No. 132013 – Narva (Viivikonna) quarry

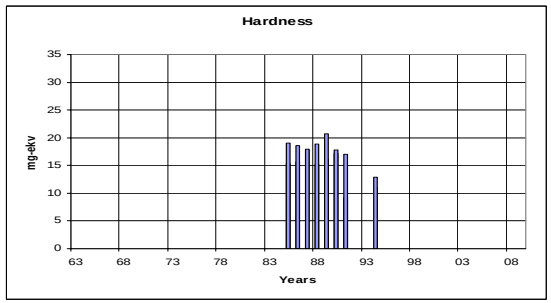


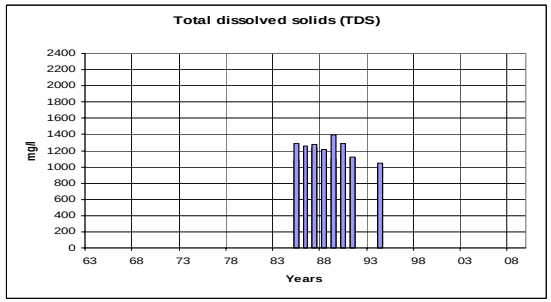




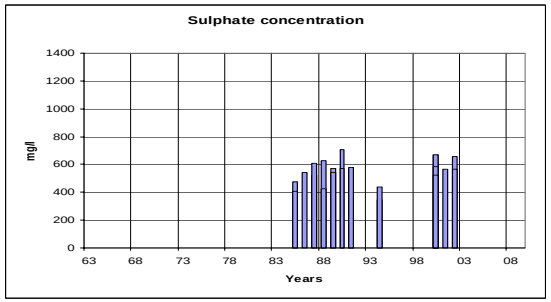
Well No. 132014 – Narva (Sirgala) quarry

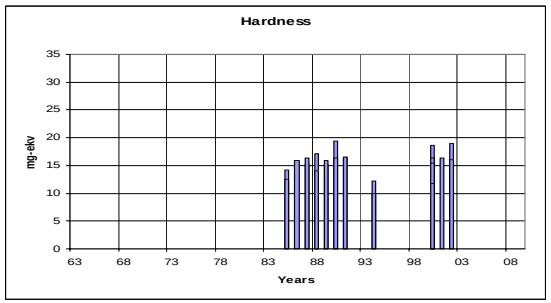


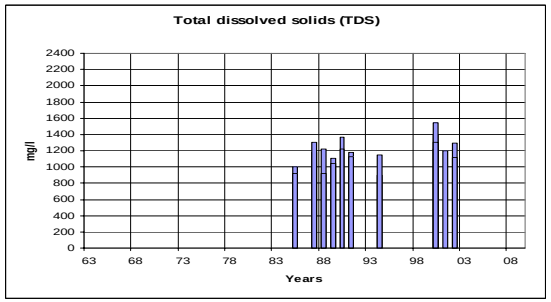




Well No. 132016 – Aidu quarry







Joonis 2. Sulfaatide, kareduse ja mineraalainete sisalduse muutused Viivikonna, Sirgala ja Aidu karjääride põhjavees aastatel 1985 – 1994.
Figure 2. Changes of concentrations of sulphates, hardness and total dissolved solids (TDS) in groundwater of open-casts Viivikonna, Sirgala and Aidu in 1985 – 1994.

groundwater flow direction, groundwater levels and groundwater chemistry. Due to mining technology, the level of groundwater of Lasnamäe–Kunda aquifer has lowered below the level of oil shale stratum. As result of vertical groundwater flow in mining areas there is no essential difference between the groundwater chemical composition in the Keila–Kukruse and the Lasnamäe–Kunda aquifers (Tables , Figures).

6.2. Nabala–Rakvere aquifer

In the flat-lying sedimentary rocks of Nabala–Rakvere aquifer underground mining is routinely accompanied by rock fracturing, dilation of joints, and separation along bedding planes. Nearby drainage systems of Estonia and Viru mines the groundwater of Nabala–Rakvere aquifer has contact with surface water enriched by sulphates and other chemical compounds from drainage water of mines. So the concentration of sulphates in groundwater close to natural conditions is 4–8 time less than in wells nearby from drainage systems of mines (Figures 3 and 4).

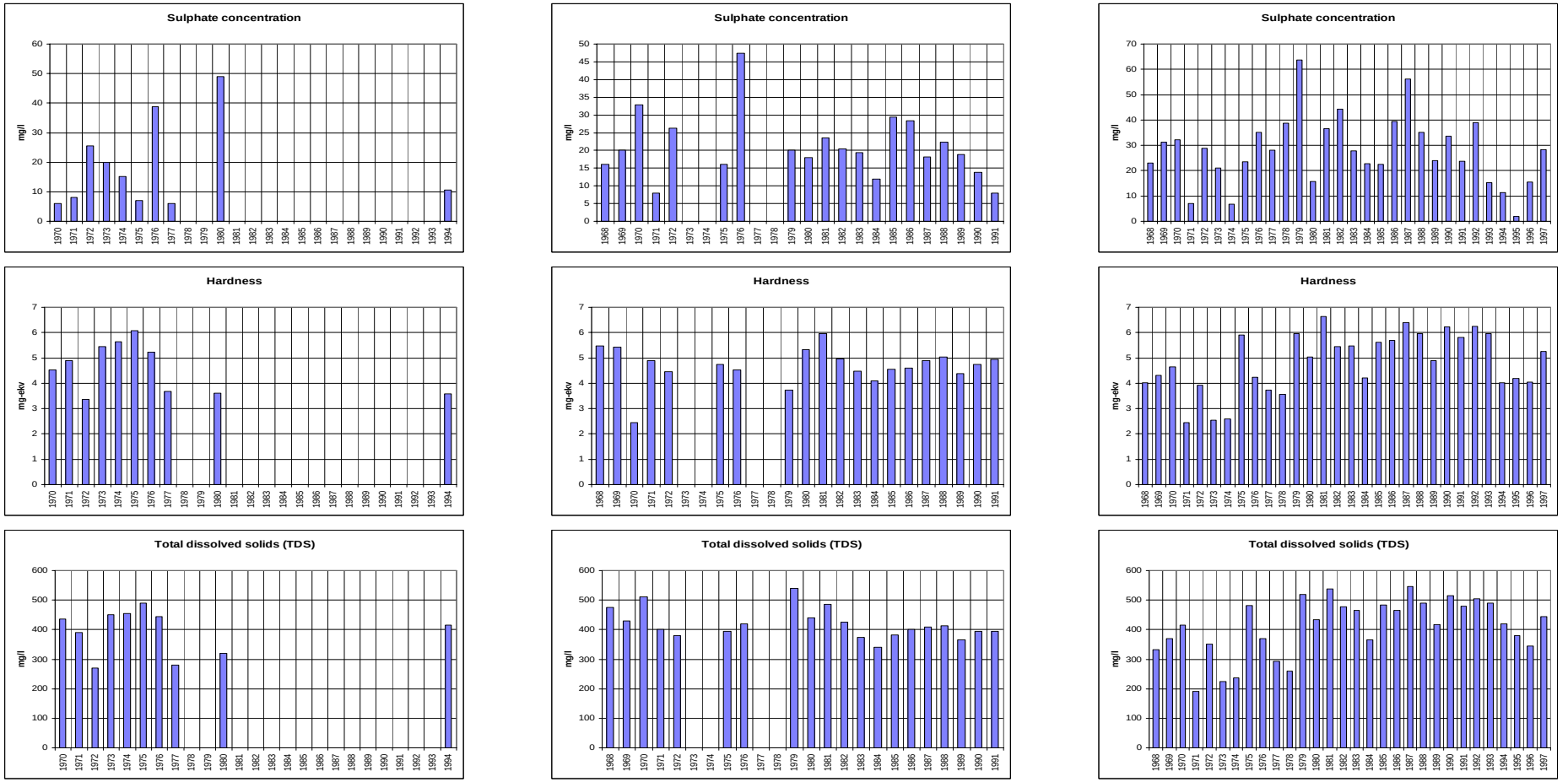
7. Mining impact on the chemistry of Lakes Kurtna and shallow groundwater of Vasavere GWB

The rise in the sulphate content of lake water is evidently due to human impact. In recent years the content of sulphate has increased both in the closed lakes and in those influenced by mining waters directly (discharge) in the southern part of the Vasavere buried valley or indirectly by mining dewatering system waters, having the sulphate values in the range of 160–259 mg/l (Erg, 2005).

Long-term research conducted in Kurtna Nature Reserve, where on the basis of some lakes systems for directing pumped-out mine water have been established, shows that compared to 1937 the concentration of sulphates in through-flowing lakes has increased tens of times (Punning et. al., 1994). If for example, in 1937 the sulphate content in lakes Nõmmejärv and Konsu was 5,8 and 1,0 mg/l, then in 2000 it was 259 and 184 mg/l respectively. Investigation of the bottom sediments of through-flowing Lake Nõmmejärv to which mine water is discharged after primary sedimentation, showed that the discharge of mine waters beginning from the 1970s has dramatically altered the state of Lake Nõmmejärv ecosystem, recorded by the composition of sediments (Punning et. al., 1997).

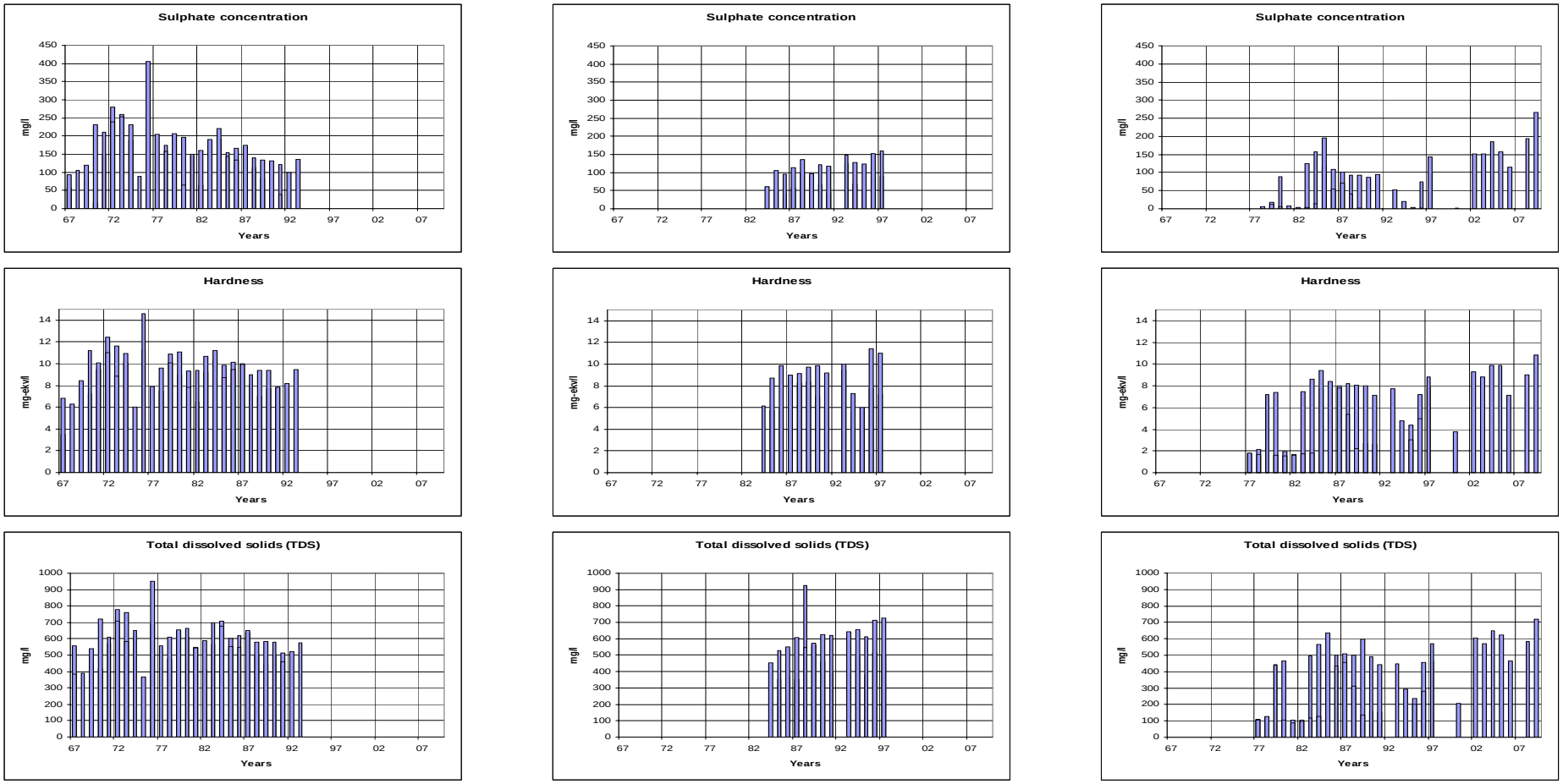
Beginning from the early 1980s the state of lakes seams to have improved. There is also evidence that decreasing amount of pumped-out mine water has a negative influence on the quality of the water of some rivers due to the decreasing amount of water in them (Punning et. al., 1997).

Well No. 2591 Well No. 2592 Well No. 2594



Joonis 3. Nabala-Rakvere veekihi põhjavee sulfaatide , kareduse ja mineraalainete sisalduse muutused looduslähedastes tingimustes (kaevandamisest mõjutamata alad).

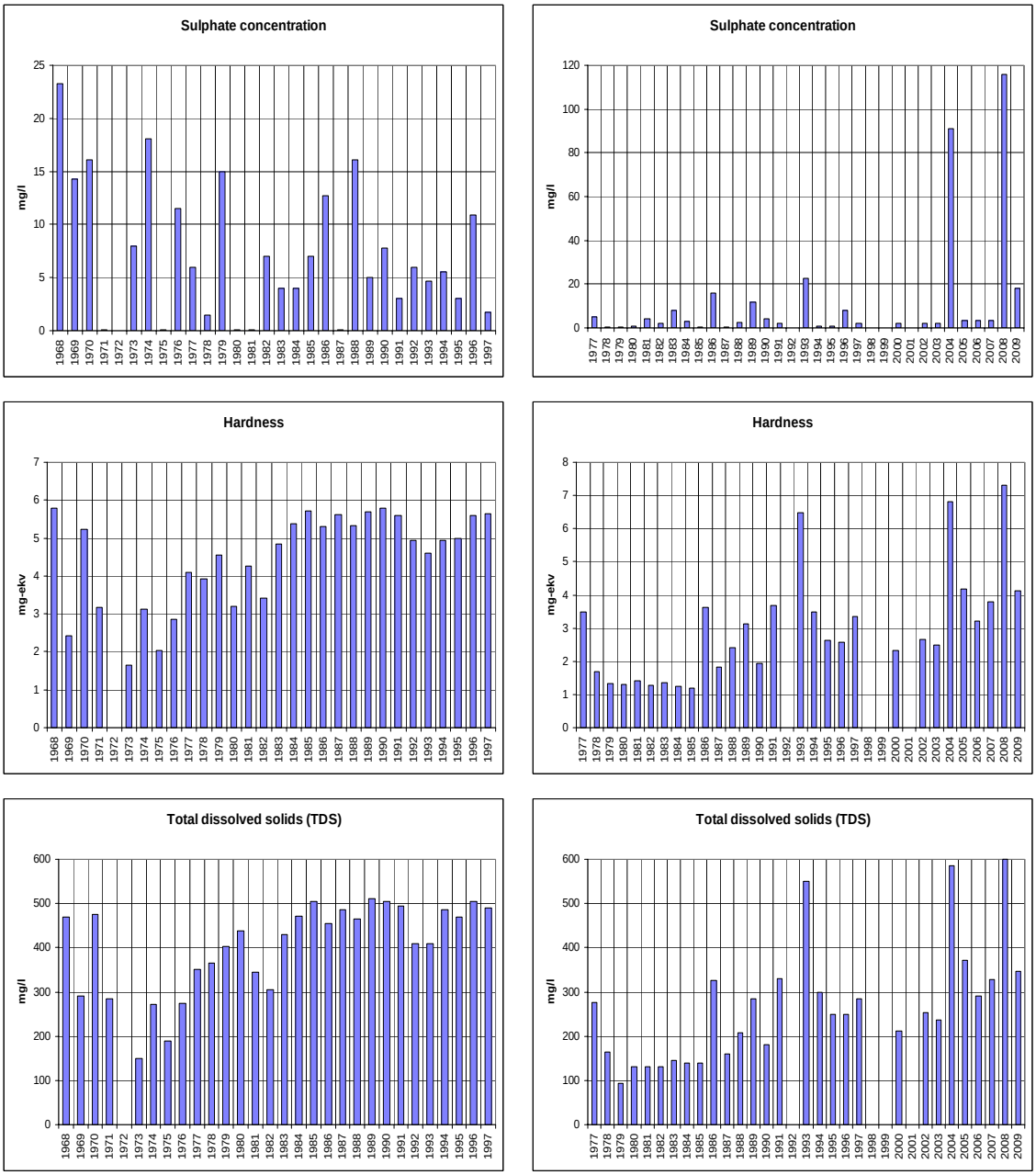
Figure 3. The changes of the sulphate concentrations, hardness and total dissolved solids in groundwater of Nabala-Rakvere aquifer in natural conditions (backround areas).



Joonis 4. Nabala-Rakvere veekihi põhjavee sulfaatide, kareduse ja mineraalainete sisalduse muutused kaevanduste dreenivee äravoolu piirkondades.

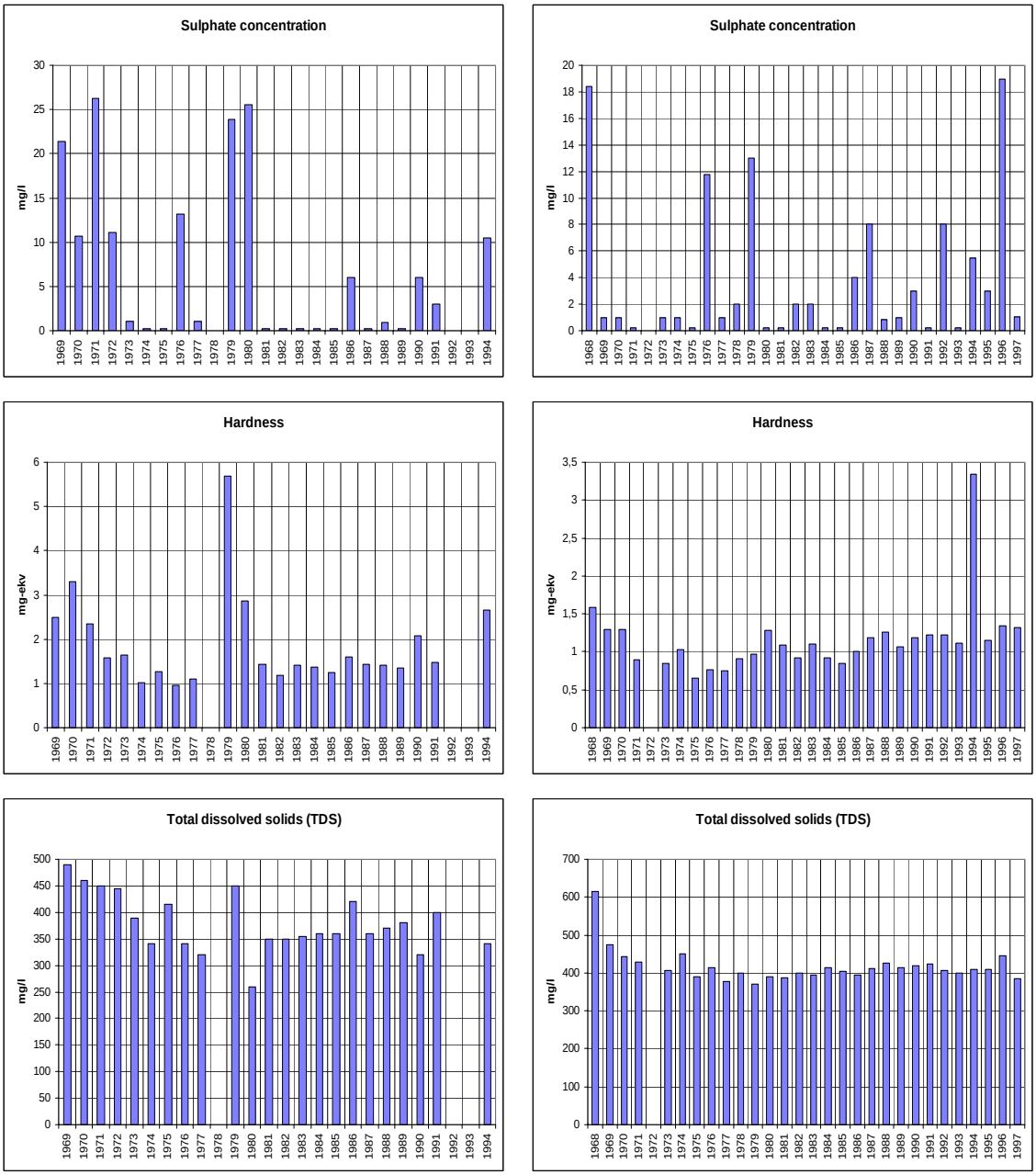
Figure 4. The changes of the sulphate concentrations, hardness and total dissolved solids in groundwater of Nabala-Rakvere aquifer in areas nearby from drainage system of mines.

Well No. 2593 Well No. 4017



Joonis 5. Keila-Kukruse veekihi põhjavee sulfaatide, kareduse ja mineraalainete sisalduse muutused looduslähedastes tingimustes (kaevandustest mõjutamata alad).
Figure 5. The changes of sulphate concentrations, hardness and total dissolved solids in groundwater of Keila-Kukruse aquifer in natural conditions (backround areas).

Well No. 2589 Well No. 2595



Joonis 6. Lasnamäe-Kunda veekihi põhjavee sulfaatide, kareduse ja mineraalainete sisalduse muutused looduslähedastes tingimustes (kaevandustest mõjutamata alad).

Figure 6. The changes of the sulphate concentrations, hardness and total dissolved solids in groundwater of Lasnamäe-Kunda aquifer in natural conditions (backround areas).

Results of hydrochemical monitoring show that the concentration of sulphates in groundwater of Vasavere groundwater body is continuously increased from 5–10 mg/l in the beginning of 1970s to 30–35 mg/l in 2006 (Figure 9). The changes of mean values of SO_4, total hardness and total dissolved solids in groundwater of Vasavere groundwater body is presented in Figure 10.

8. Sulphate concentration changes in groundwater after closure of mines

During mining the water level drowning and increasing aeration zone cause intensive pyrite oxidation, which is the biggest groundwater contamination problem associated with oil shale mining.

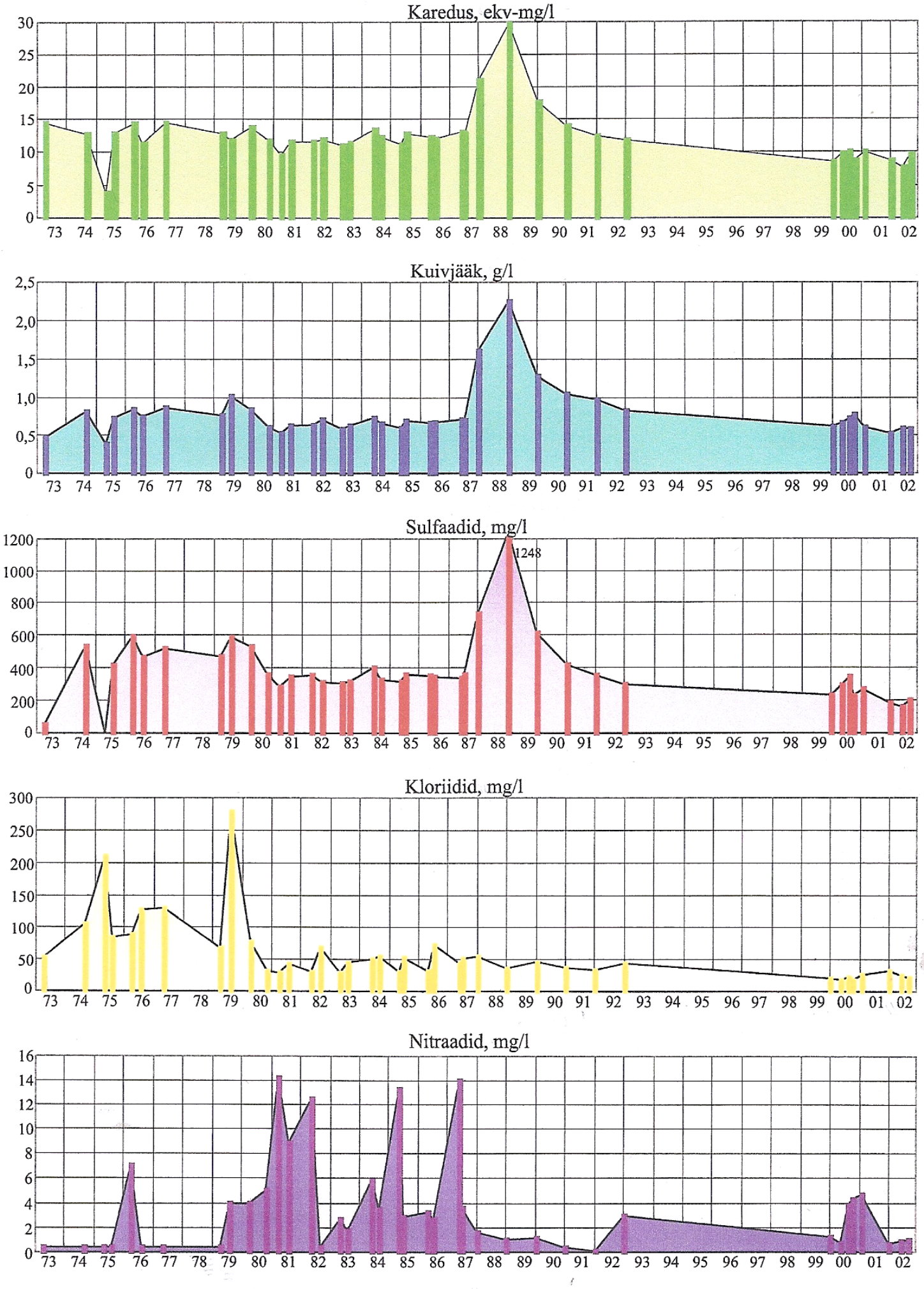
After mines are closed, step-by-step restoration of natural conditions of the groundwater filling the mines starts – sulphates are carried out, the effect of air oxygen on the mineable seams that used to be drained disappears. As a result, oxidation of pyrite diminishes and the mineral content of the water pumped out decreases.

Quality studies of mine water have shown that in about five years after the closure of a mine the concentration of sulphates and iron decreases below the maximum permitted level in drinking water. The highest permitted concentration of iron in drinking water is 0,2 mg/l and that of sulphates 250 mg/l.

The maximum concentrations of sulphates has been analysed during first year after closing of mine. In groundwater of Kiviõli oil shale mine the concentration of sulphates after closure of mine arose from 400 mg/l to 1200 mg/l, but after 5 years has stabilized on the level of 200 mg/l (Figure 7). Diminishing of sulphate concentrations during last year has been observed also in groundwater of monitoring wells nearly closed mines Sompa, Tammiku and Kohtla (Figure 8), where concentrations of sulphates have remained high and still stays 10 times higher than its natural background (Figure 8).

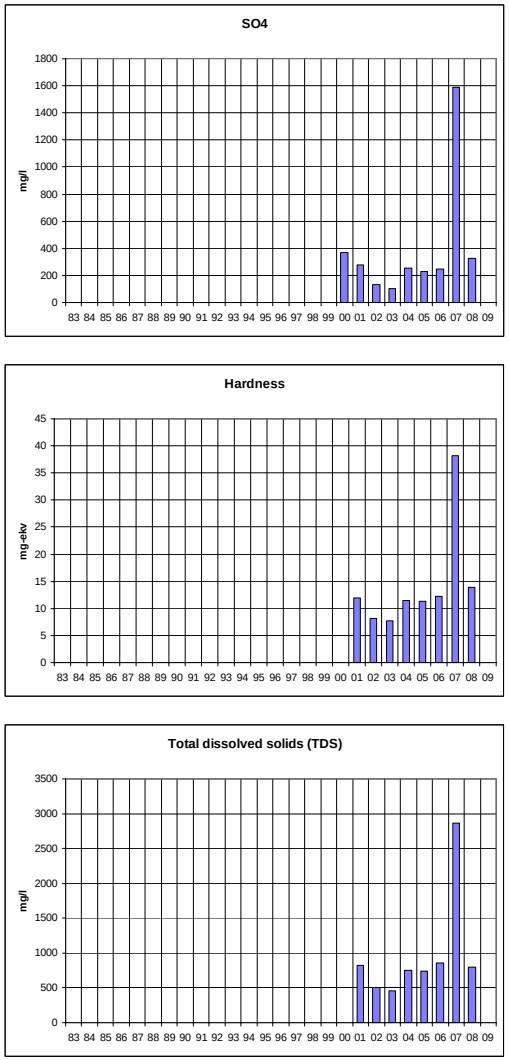
In the earliest closed Kukruse and Mine No 2 the sulphate concentration has been high also in groundwater of the Lasnamäe–Kunda aquifer. Also in the southern part of Kohtla mine and in the northern part of Sompa mine the sulphate concentration has been between 200–350 mg/ (Appendix 1, Table 2).

Changes in the chemical composition are naturally accompanied by intensive removal of the sulphates recharging Ordovician carbonate rocks. Significant enrichment of water with sulphates takes place in the carbonate rocks in the aeration zone. There is increasing evidence that portions of the water infiltrating through the soil surface may move rapidly through the aeration zone along

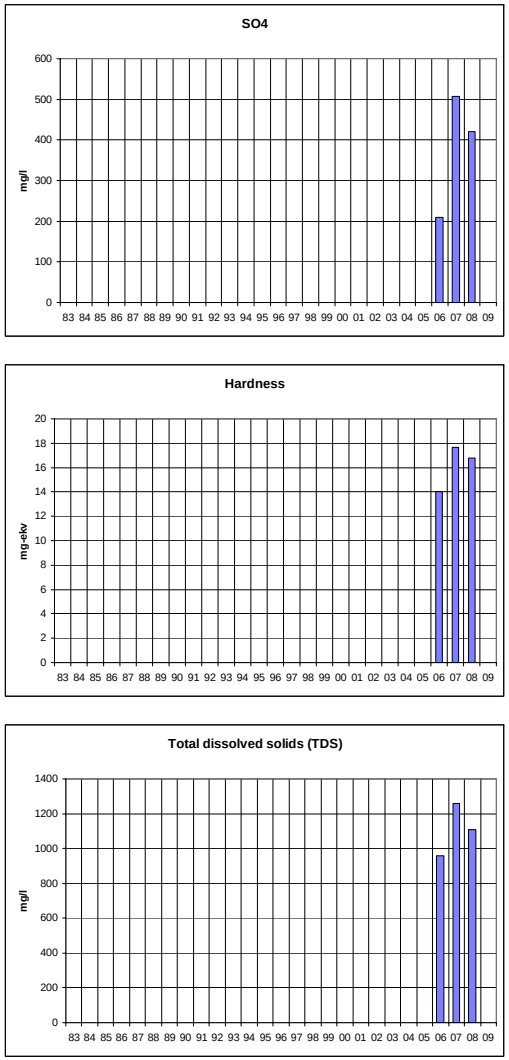


Joonis 7. Kiviõli kaevandusest ärajuhitava vee keemilise koostise muutused.
Figure 7. Changes of chemical composition of closed Kiviõli oil shale mine.

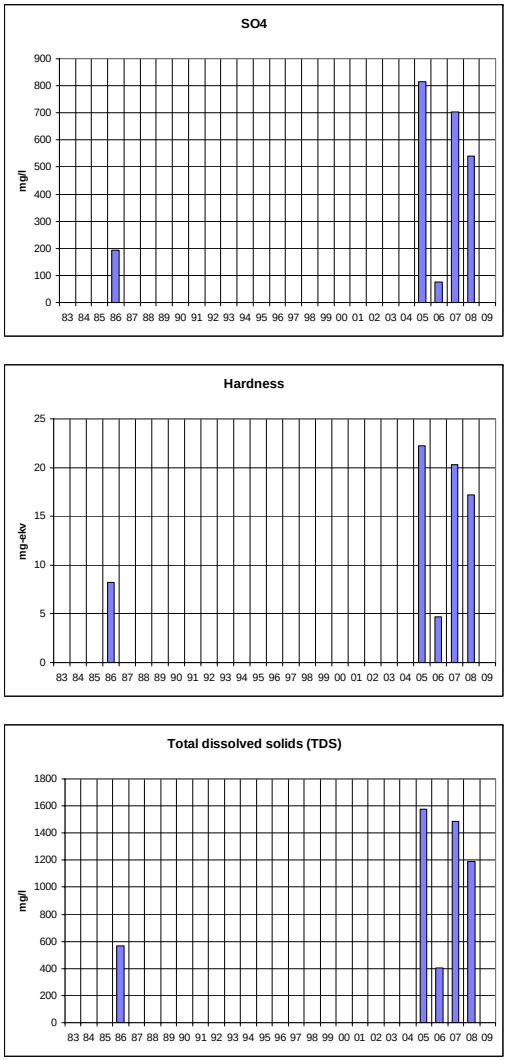
Well No. 16703 – Sompa



Well No. 16919 – Tammiku

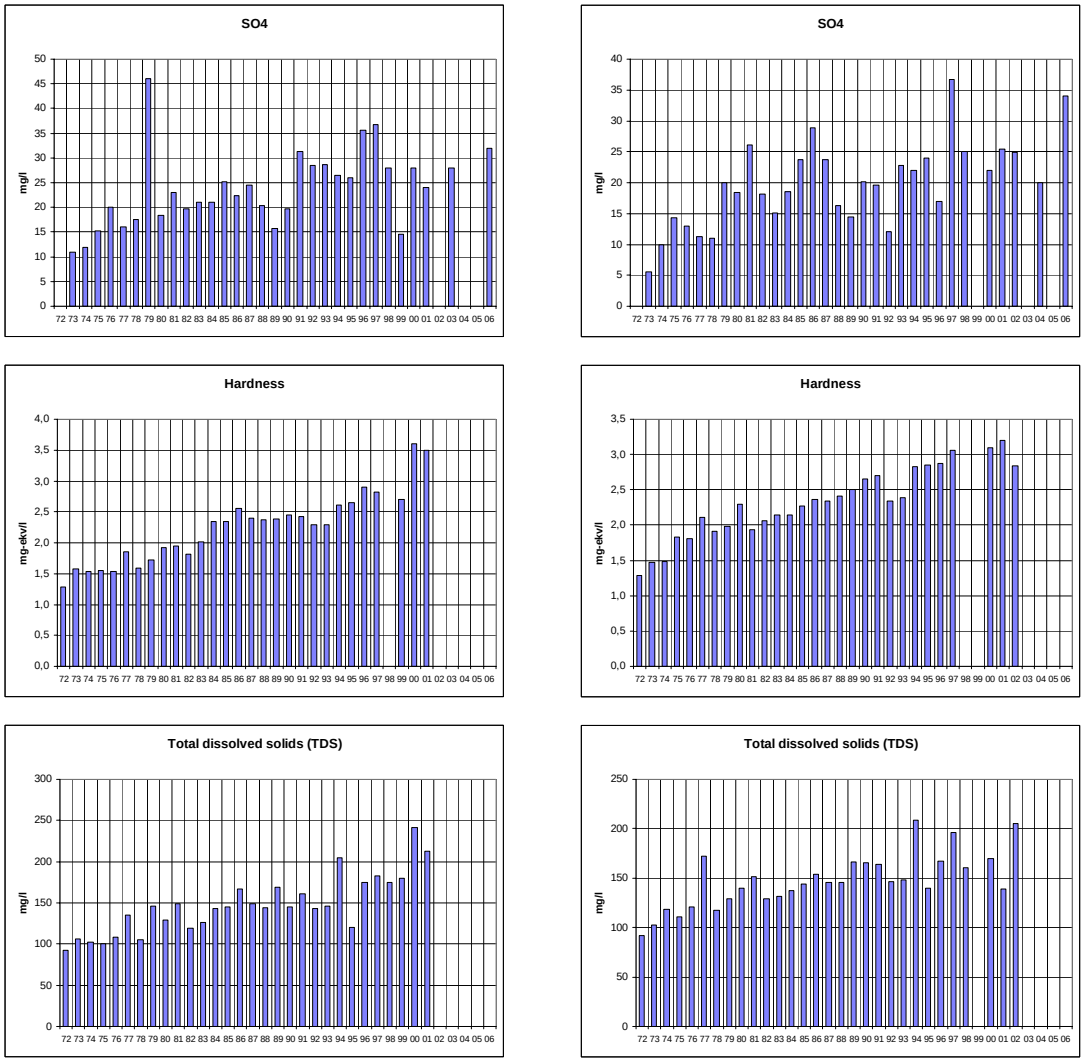


Well No. 3659 – Kohtla



Joonis 8. Suletud Sompa, Tammiku ja Kohtla kaevanduste põhjavee sulfaatide, kareduse ja mineraalainete sisalduse muutused.
Figure 8. Changes of concentrations of sulphates, hardness and total dissolved solids in groundwater of closed Sompa, Tammiku and Kohtla mines.

Well No. 3228 Well No. 3231



Joonis 9. Vasavere põhjaveekogumi põhjavee sulfaatide, kareduse ja lahustunud mineraalainete sisalduse muutused vaatluskaevude 3228 ja 3231 näitel.
Figure 9. Changes of concentrations of sulphates, hardness and total dissolved solids (TDS) in groundwater of monitoring wells of Vasavere GWB 3228 and 3231.

preferred flow paths such as macrospores and fractures. In many cases, the water has low pH and contains elevated levels of sulphate ions (Erg, 2005).

The concentration of sulphates is higher in spring than during the remaining seasons of the year. It can be caused by dissolution of pyrites in oxygen-abundant water in spring.

9. Lateral distribution of sulphate in oil shale mining area

Lateral distribution of precipitation depends on precipitation and groundwater level in closed and active mines. The sulphate may distribute in a lateral directions many times higher than in transversal direction. This may be explained with the permeability of groundwater aquifer. Due to low transversal permeability the chemical composition and concentration of sulphate in groundwater of Ordovician–Cambrian and Ordovician Ida-Viru oil shale basin groundwater bodies are rather different (Figures 11 and 12). Concentration of sulphate in groundwater of Ordovician aquifers in oil shale mining area exceeds 4–10 time a corresponding values of Ordovician–Cambrian aquifer. The same thing happens if compare the concentration of sulphate in groundwater of Ida-Viru oil shale basin groundwater body with groundwater of Ordovician Ida-Viru groundwater body (Figures 12 and 13).

There are obvious differences also in concentration of sulphate in the groundwater of different aquifers (Figures 14–16).

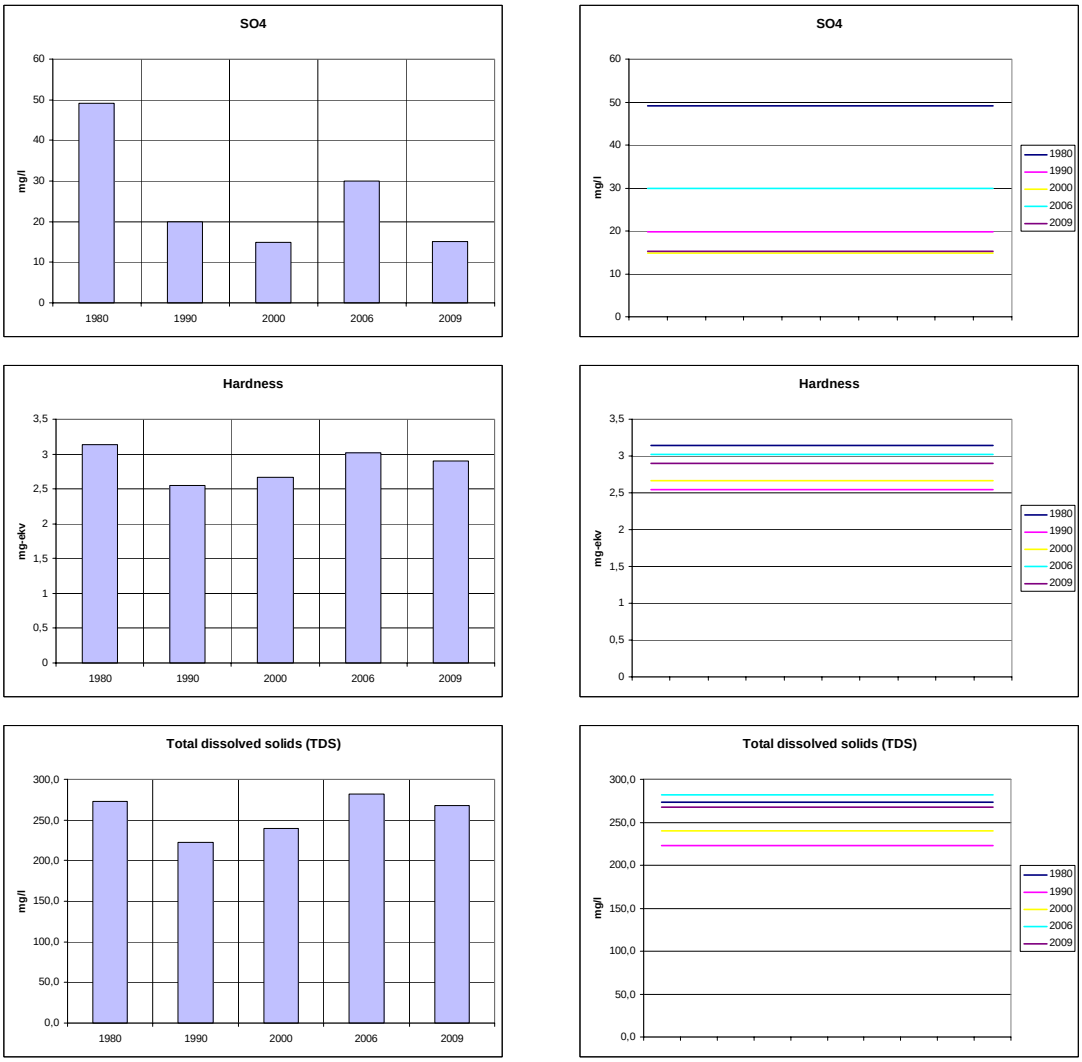
The concentration and changes of lateral distribution of sulphates in the groundwater of Keila–Kukruse aquifer in the underground mines and Aidu open-cast area in the different times are presented on Figures 17–21. Rather stable has been the sulphate concentration of groundwater of Quaternary aquifer system in Vasavere area (Figures 22–26). Only in 1992 was noticed elevated concentration of sulphate in the north-eastern part of Vasavere buried valley (Figure 24).

10. Pathlines and travel times in groundwater modelling

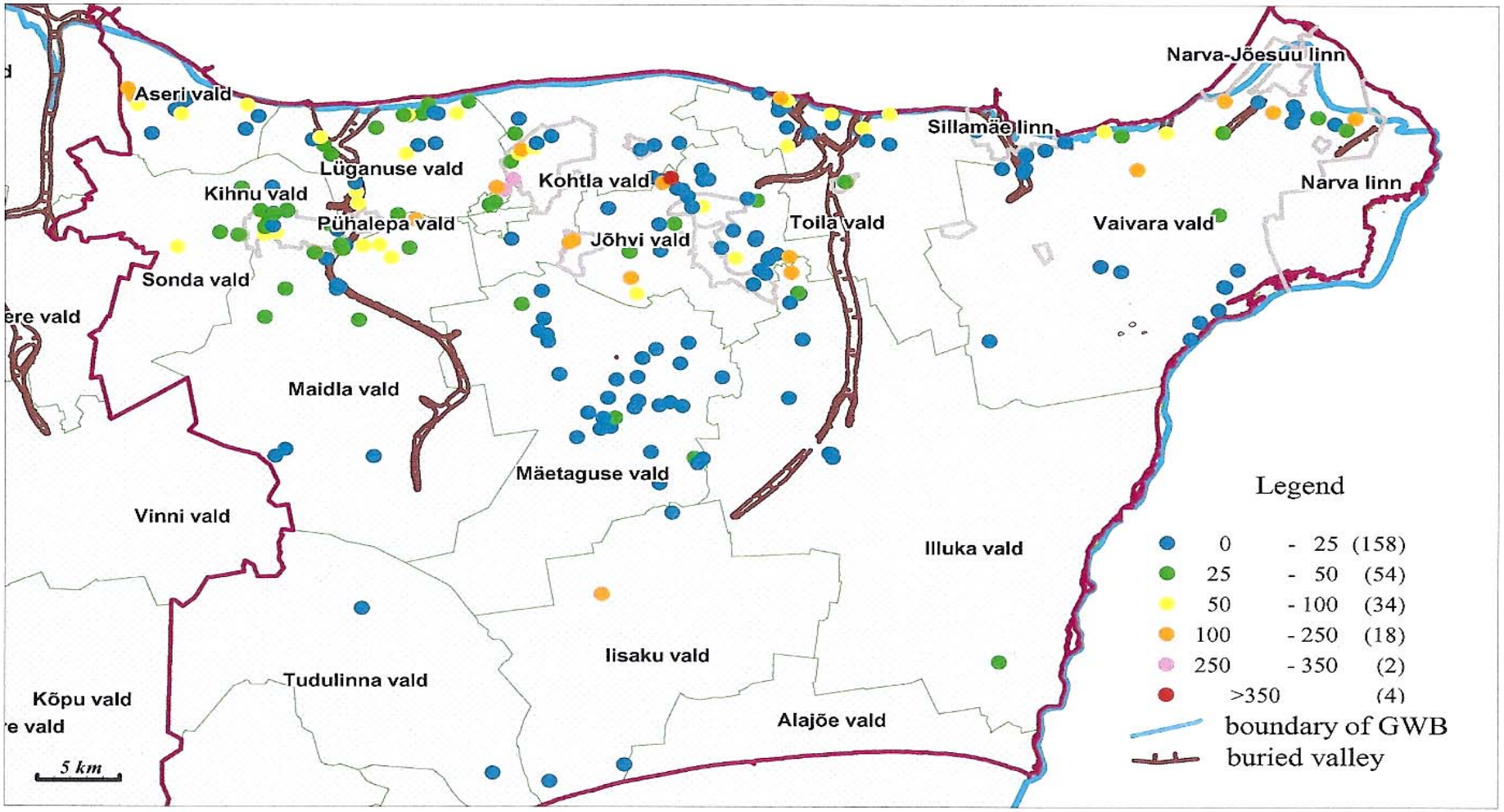
Commonly, one distinguished two main types of groundwater modelling:

- **modelling (simulation) of groundwater heads** (or piezometric heads) and fluxes, by so-called groundwater flow models), and
- modelling (simulation) of solute concentration, by so-called solute transport models (also named contaminant transport models).

The modelling of pathlines and travel times falls in-between these two main modelling categories. In fact, it constitutes the link between these modelling categories. To put it strongly, **solving the groundwater flow problem is a precondition for solving a groundwater quality problem by a solute transport model** (Kovar, 2008).

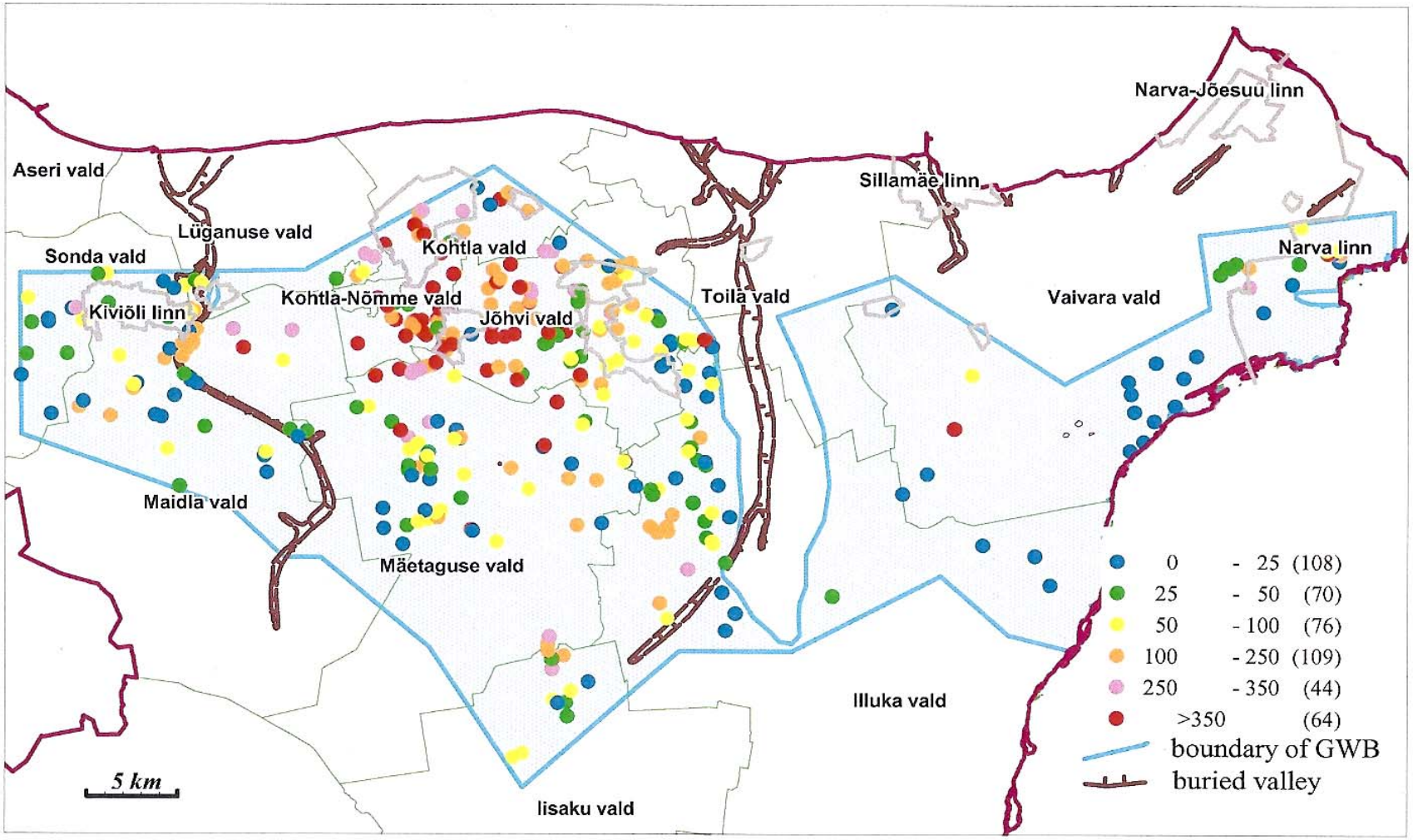


Joonis 10. Vasavere põhjaveekogumi põhjavee keemilise koostise (SO_4, karedus ja mineraalainete sisalduse keskmine väärtus) muutused ajavahemikus 1980 – 2009.
Figure 10. The changes of chemical composition (mean values of SO_4, hardness and total dissolved solids (TDS)) of groundwater of Vasavere GWB in 1980 – 2009.



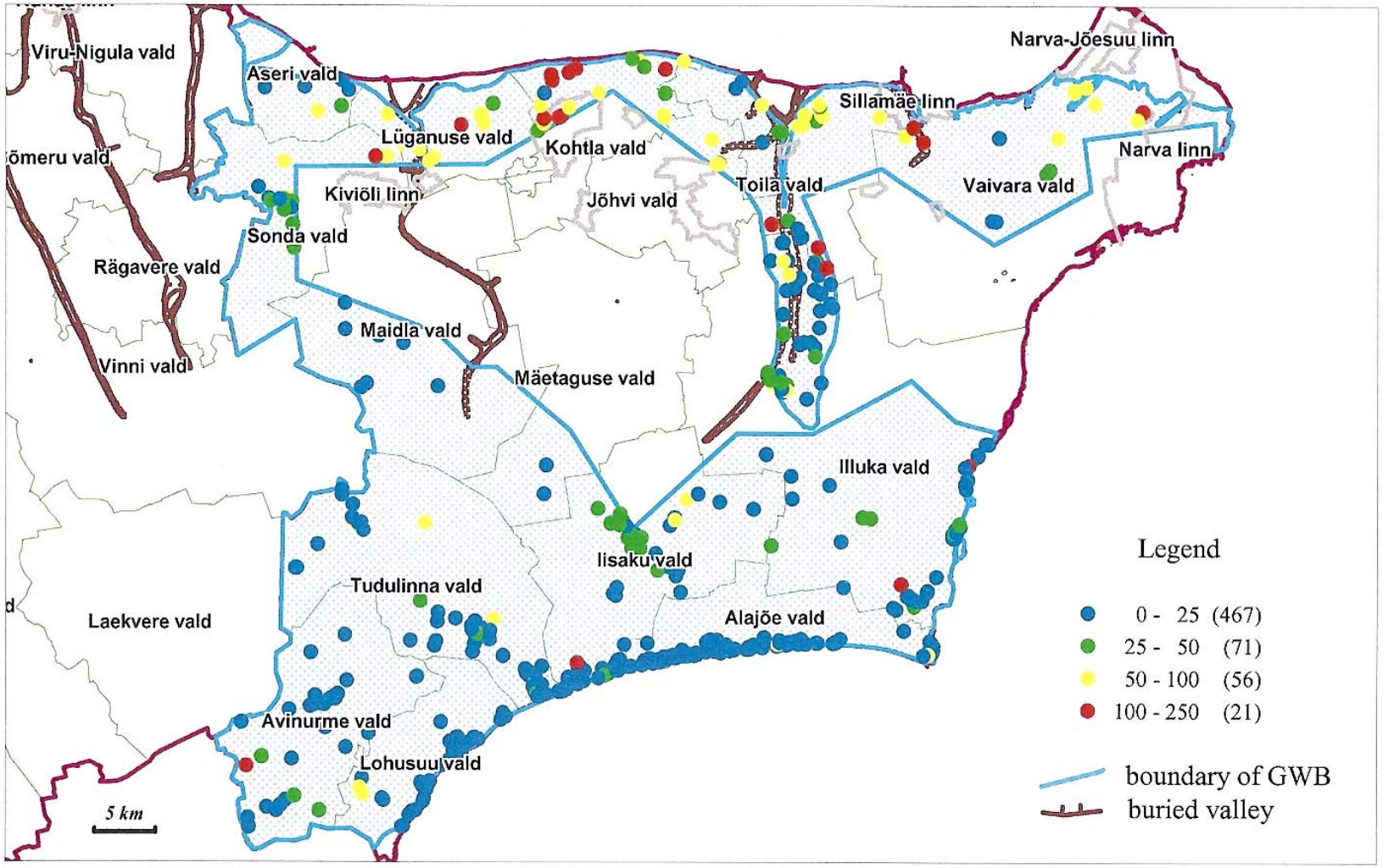
Joonis 11. SO_4 levik Ordoviitsiumi-Kambriumi põhjaveekogumi põhjavees

Figure 11. Distribution of SO_4 concentrations in groundwater of Ordovician-Cambrian GWB



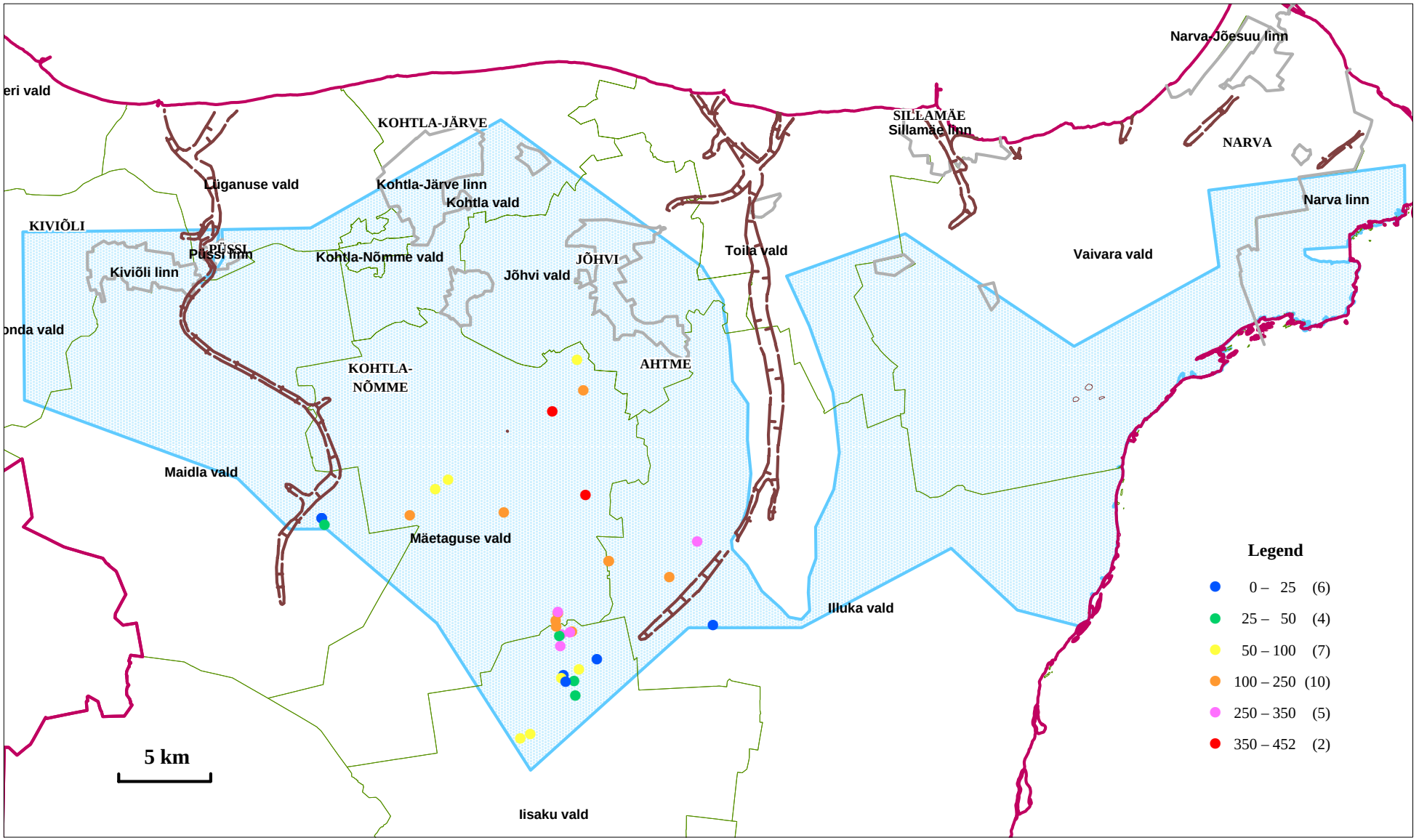
Joonis 12 SO_4 levik Ordoviitsiumi Ida-Viru põlevkivibasseini põhjaveekogumi põhjavees.

Figure 12. Distribution of SO_4 concentrations in groundwater of Ordovician Ida-Viru oil shale basin GWB



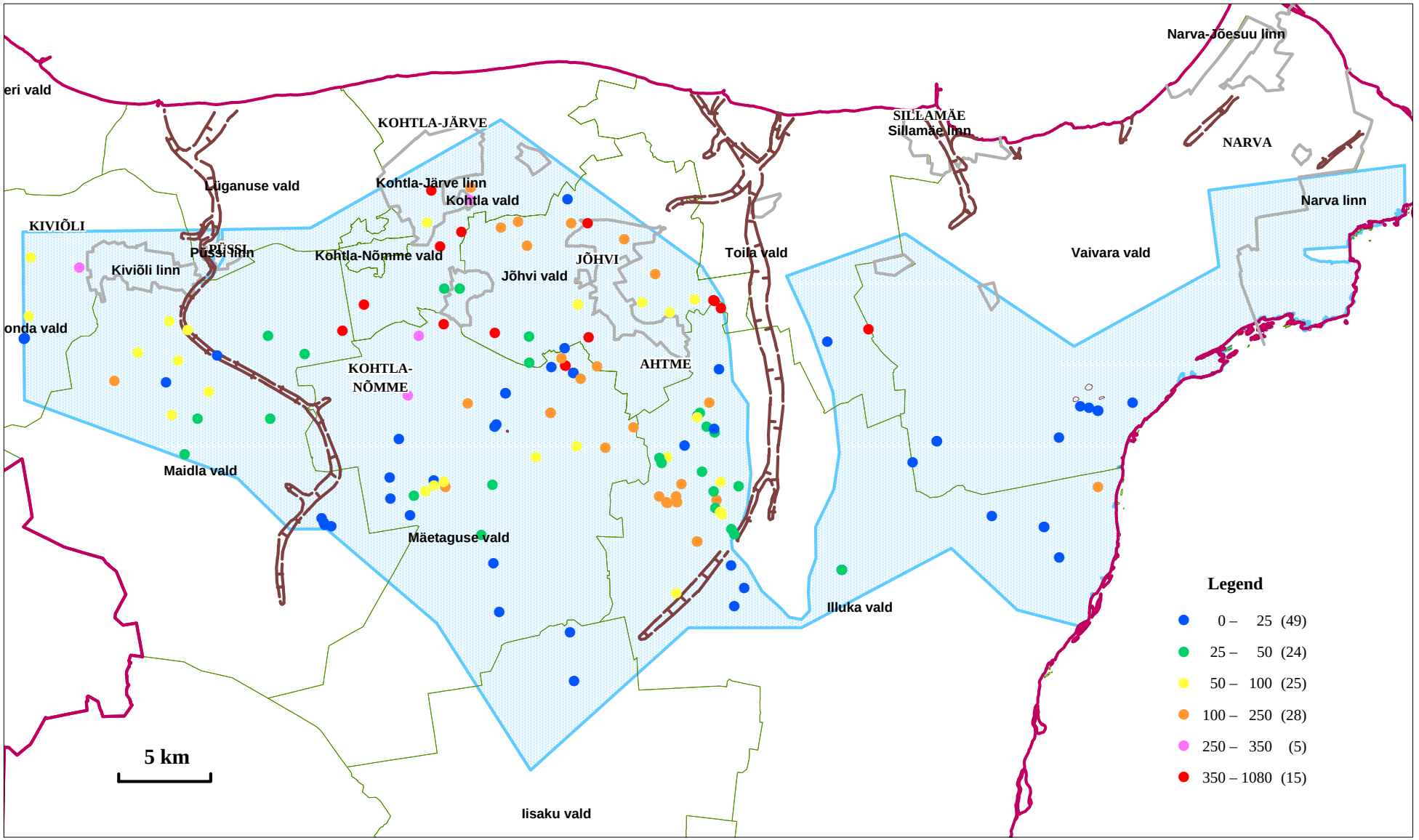
Joonis 13. SO_4 levik Ordoviitsiumi Ida-Viru põhjaveekogumi põhjavees.

Figure 13. Distribution of SO_4 concentrations in groundwater of Ordovician Ida-Viru GWB



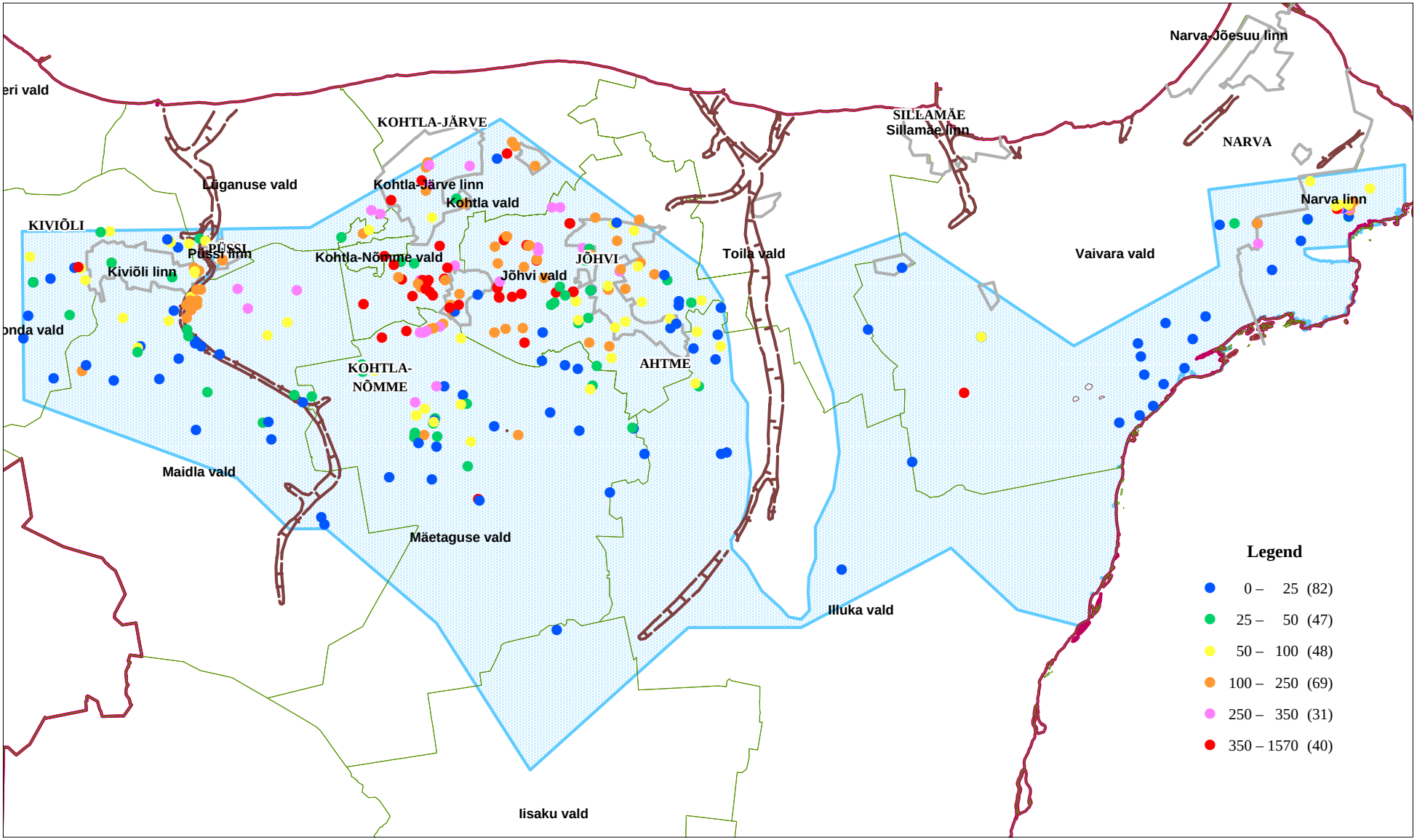
Joonis 14. SO_4 levik Nabala-Rakvere veekihi põhjavees

Figure 14. Distribution of SO_4 concentrations in groundwater of Nabala-Rakvere aquifer



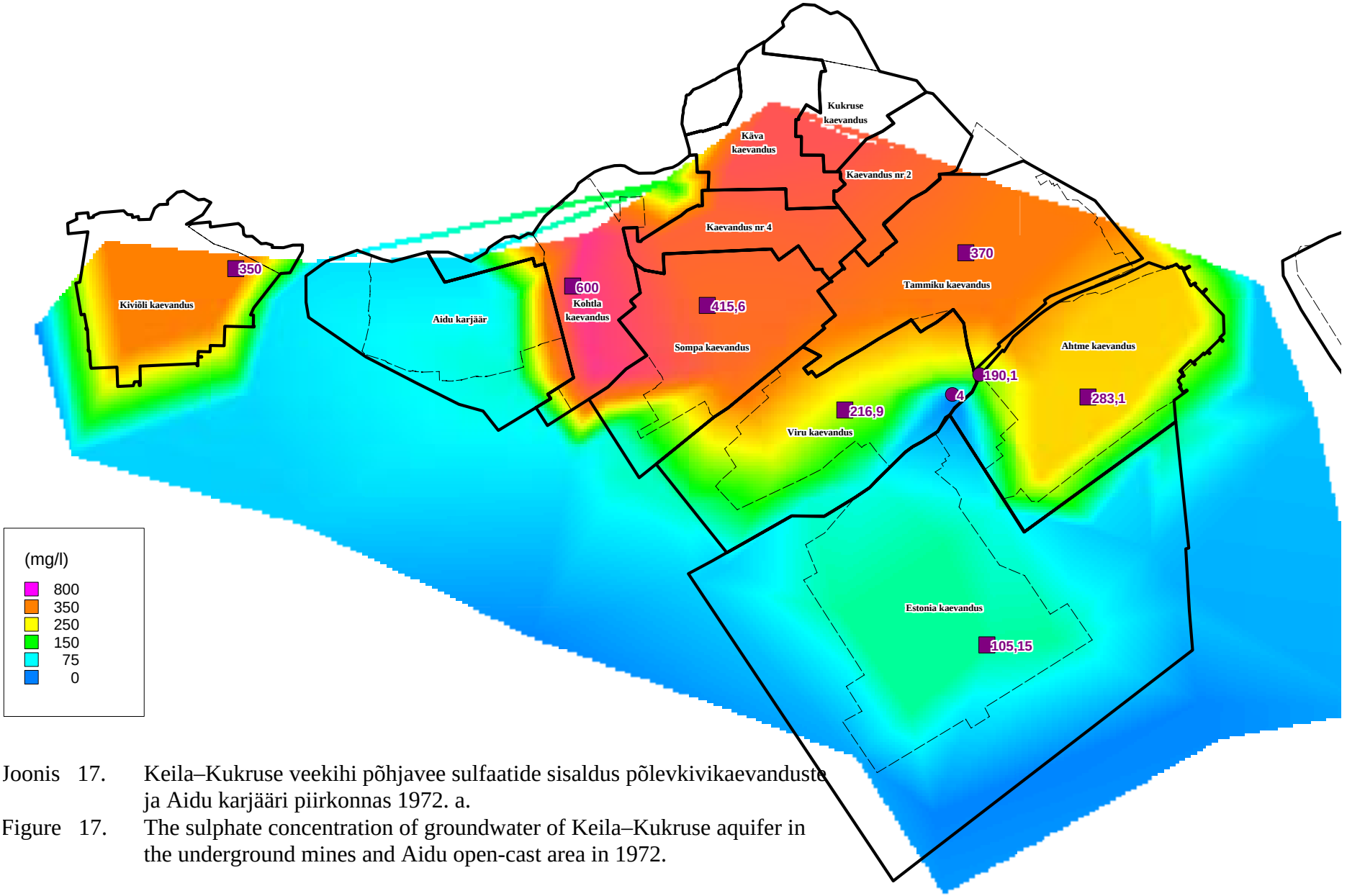
Joonis 15. SO_4 levik Keila-Kukruse veekihi põhjavees

Figure 15. Distribution of SO_4 concentrations in groundwater of Keila-Kukruse aquifer



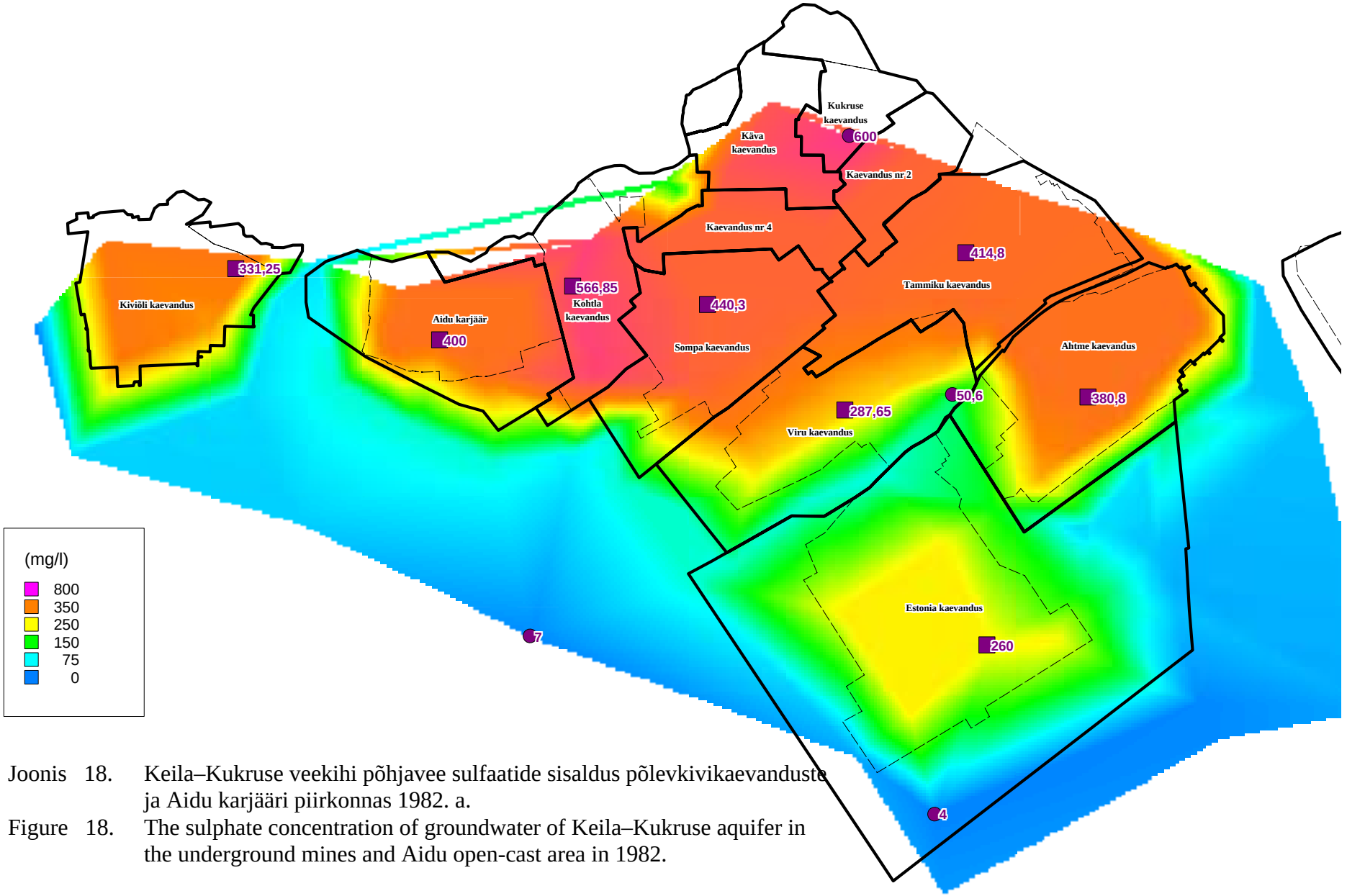
Joonis 16. SO_4 levik Lasnamäe-Kunda veekihi põhjavees

Figure 16. Distribution of SO_4 concentrations in groundwater of Lasnamäe-Kunda aquifer



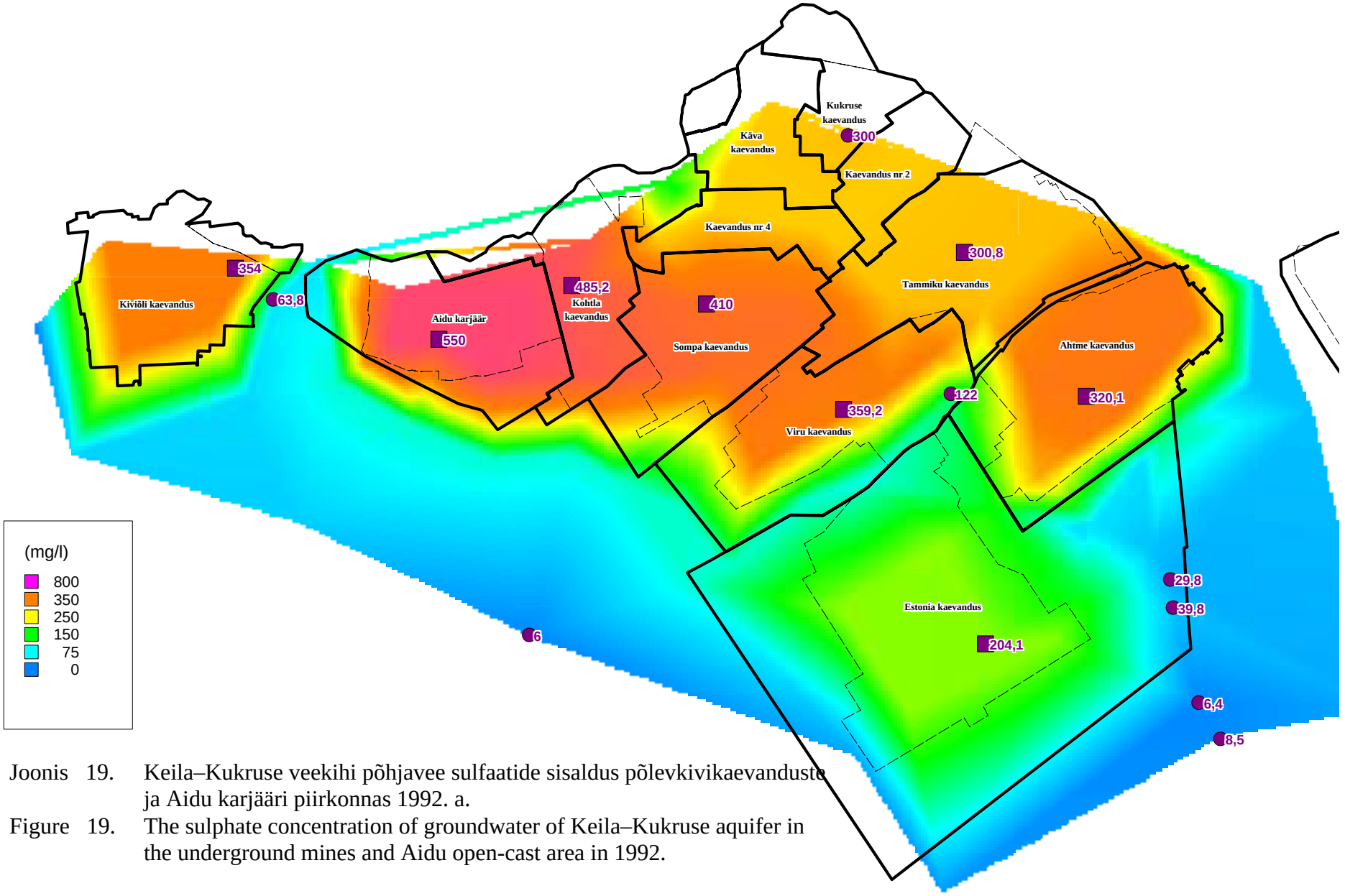
Joonis 17. Keila–Kukruse veekihi põhjavee sulfaatide sisaldus põlevkivikaevanduste ja Aidu karjääri piirkonnas 1972. a.

Figure 17. The sulphate concentration of groundwater of Keila–Kukruse aquifer in the underground mines and Aidu open-cast area in 1972.



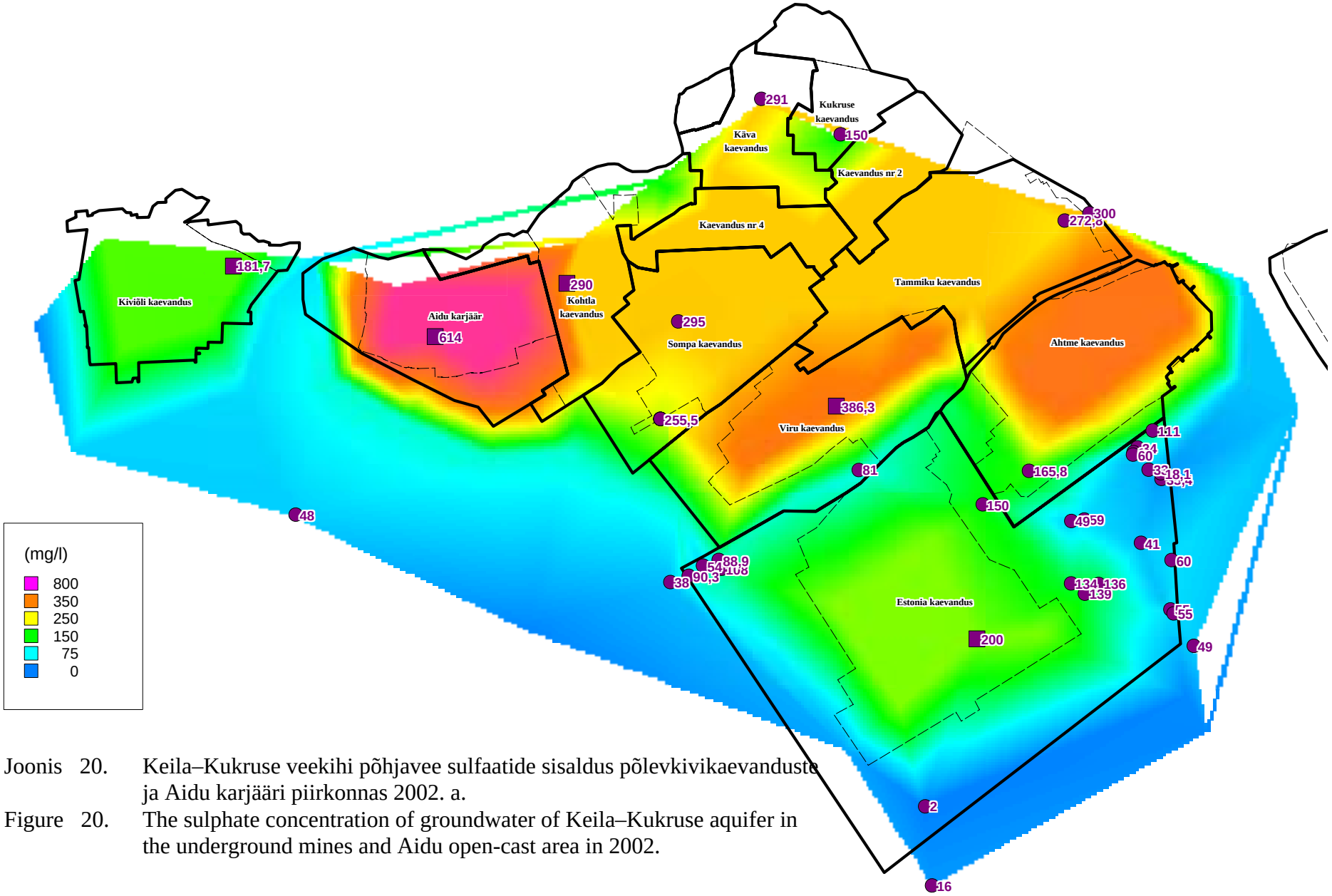
Joonis 18. Keila–Kukruse veekihi põhjavee sulfaatide sisaldus põlevkivikaevanduste ja Aidu karjääri piirkonnas 1982. a.

Figure 18. The sulphate concentration of groundwater of Keila–Kukruse aquifer in the underground mines and Aidu open-cast area in 1982.



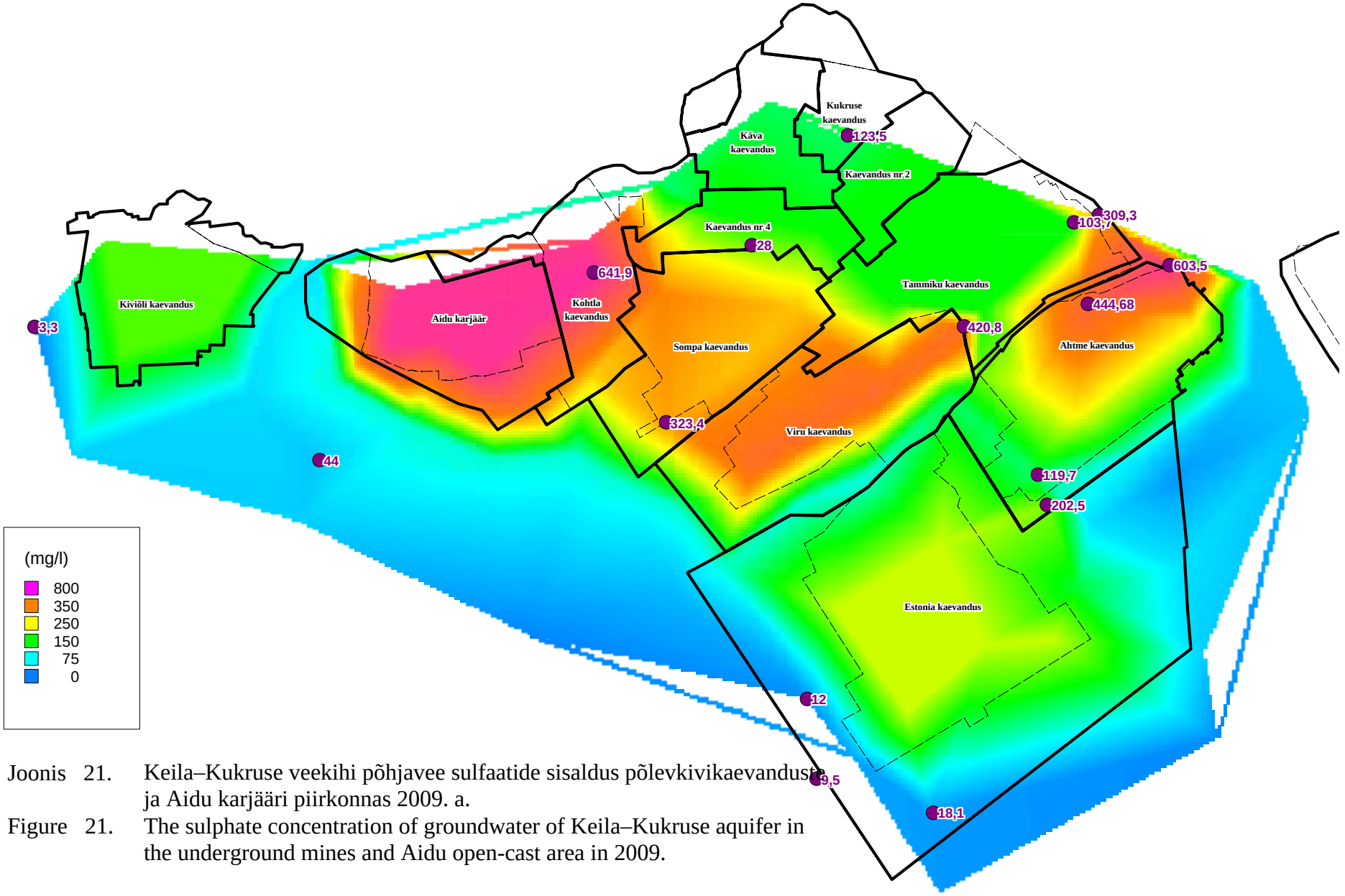
Joonis 19. Keila–Kukruse veekihi põhjavee sulfaatide sisaldus põlevkivikaevanduste ja Aidu karjääri piirkonnas 1992. a.

Figure 19. The sulphate concentration of groundwater of Keila–Kukruse aquifer in the underground mines and Aidu open-cast area in 1992.



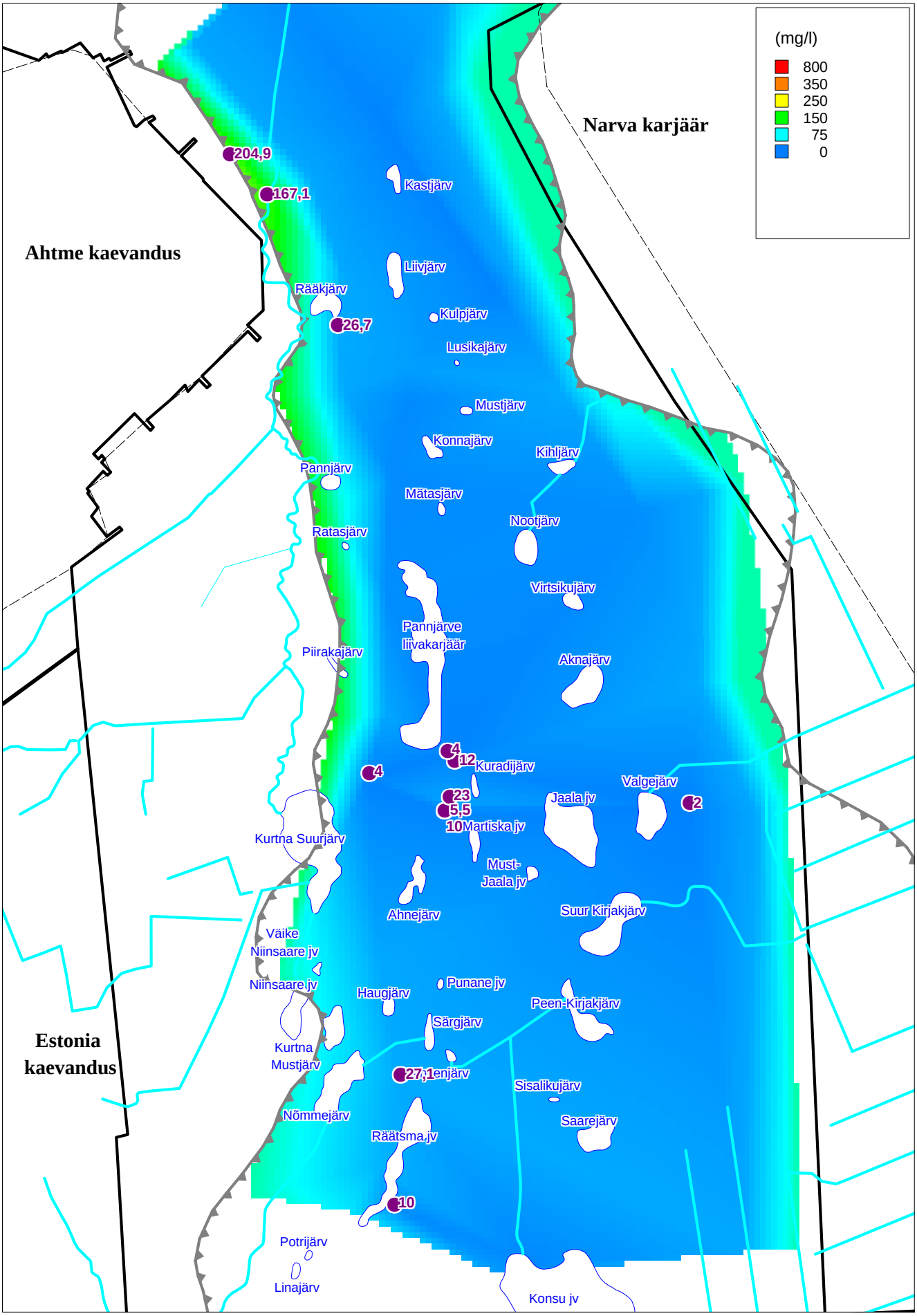
Joonis 20. Keila–Kukruse veekihi põhjavee sulfaatide sisaldus põlevkivikaevanduste ja Aidu karjääri piirkonnas 2002. a.

Figure 20. The sulphate concentration of groundwater of Keila–Kukruse aquifer in the underground mines and Aidu open-cast area in 2002.



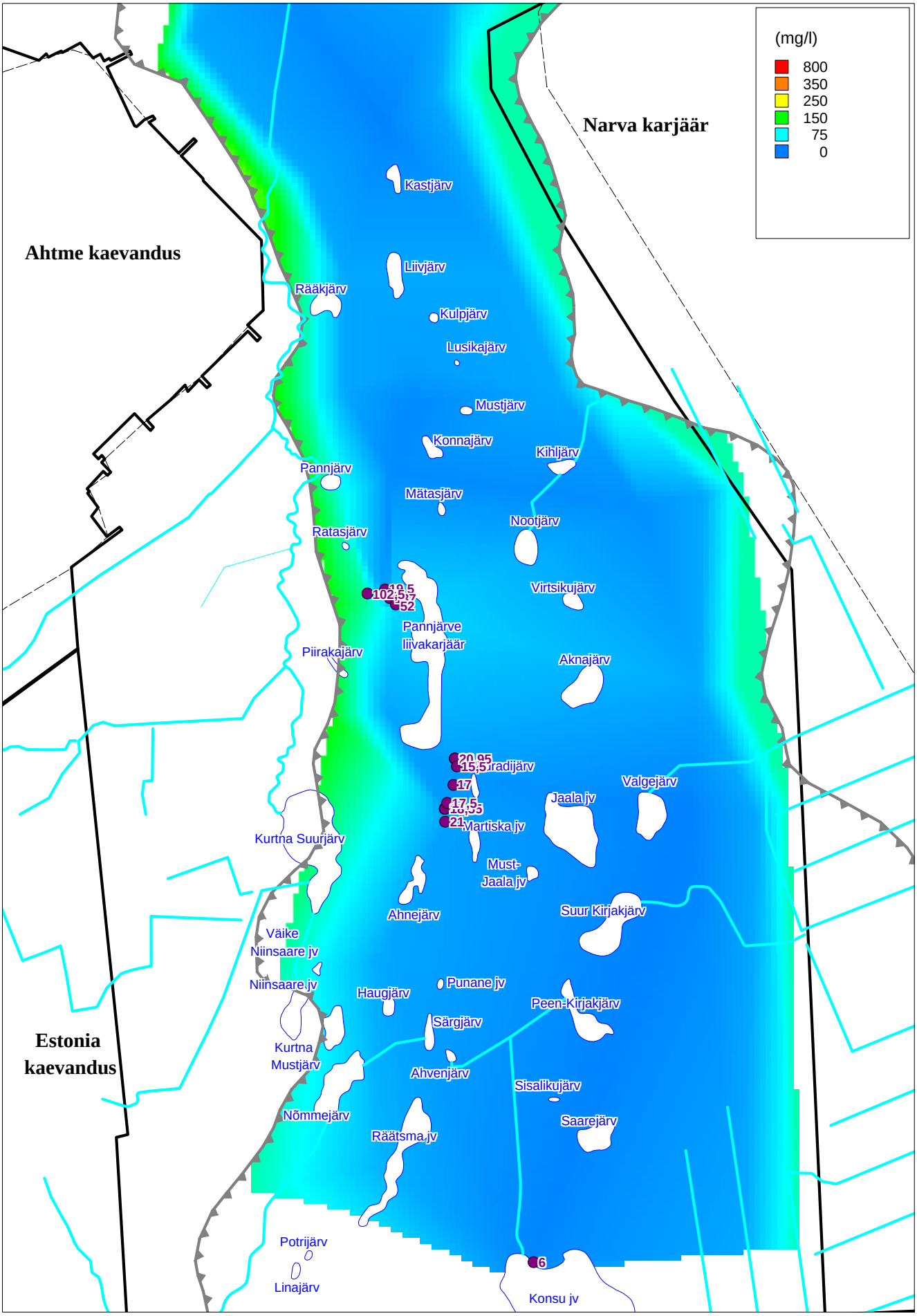
Joonis 21. Keila–Kukruse veekihi põhjavee sulfaatide sisaldus põlevkivikaevanduste ja Aidu karjääri piirkonnas 2009. a.

Figure 21. The sulphate concentration of groundwater of Keila–Kukruse aquifer in the underground mines and Aidu open-cast area in 2009.



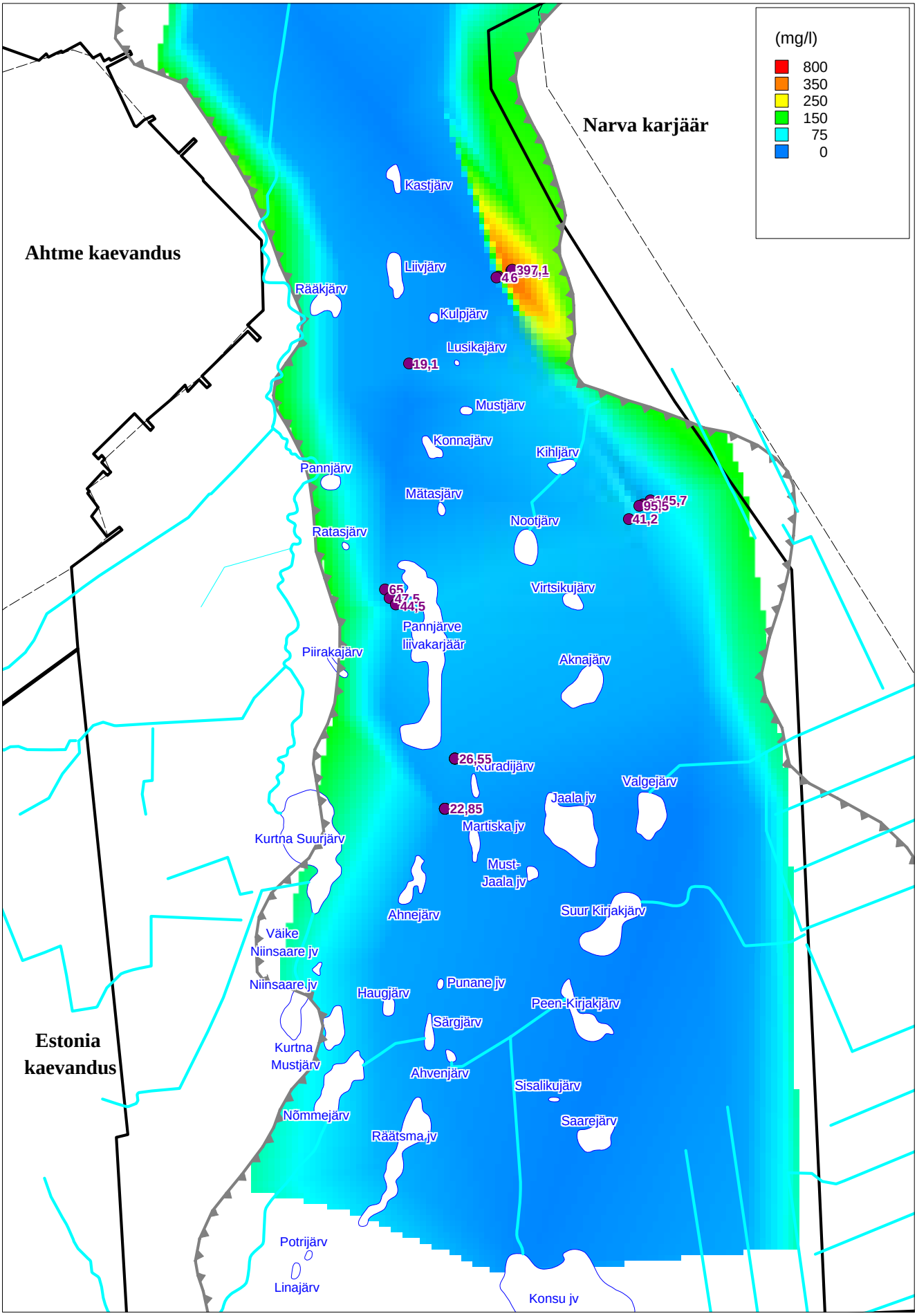
Joonis 22. Kvaternaari veekompleksi põhjavee sulfaatide sisaldus Vasavere piirkonna 1972. a.

Figure 22. The sulphate concentration of groundwater of Quaternary aquifer in Vasavere area in 1972.



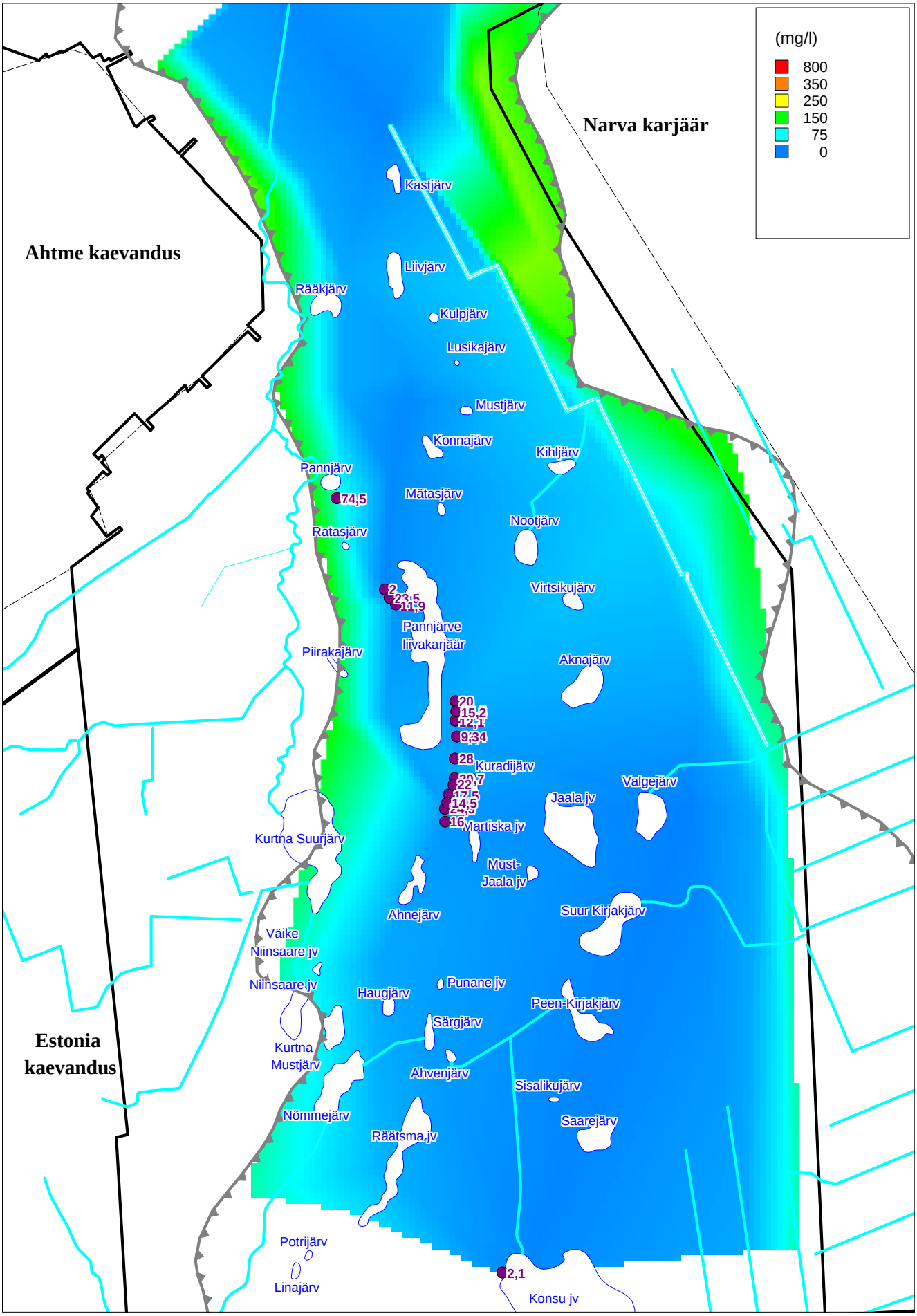
Joonis 23. Kvaternaari veekompleksi põhjavee sulfaatide sisaldus Vasavere piirkonna 1982. a.

Figure 23. The sulphate concentration of groundwater of Quaternary aquifer in Vasavere area in 1982.



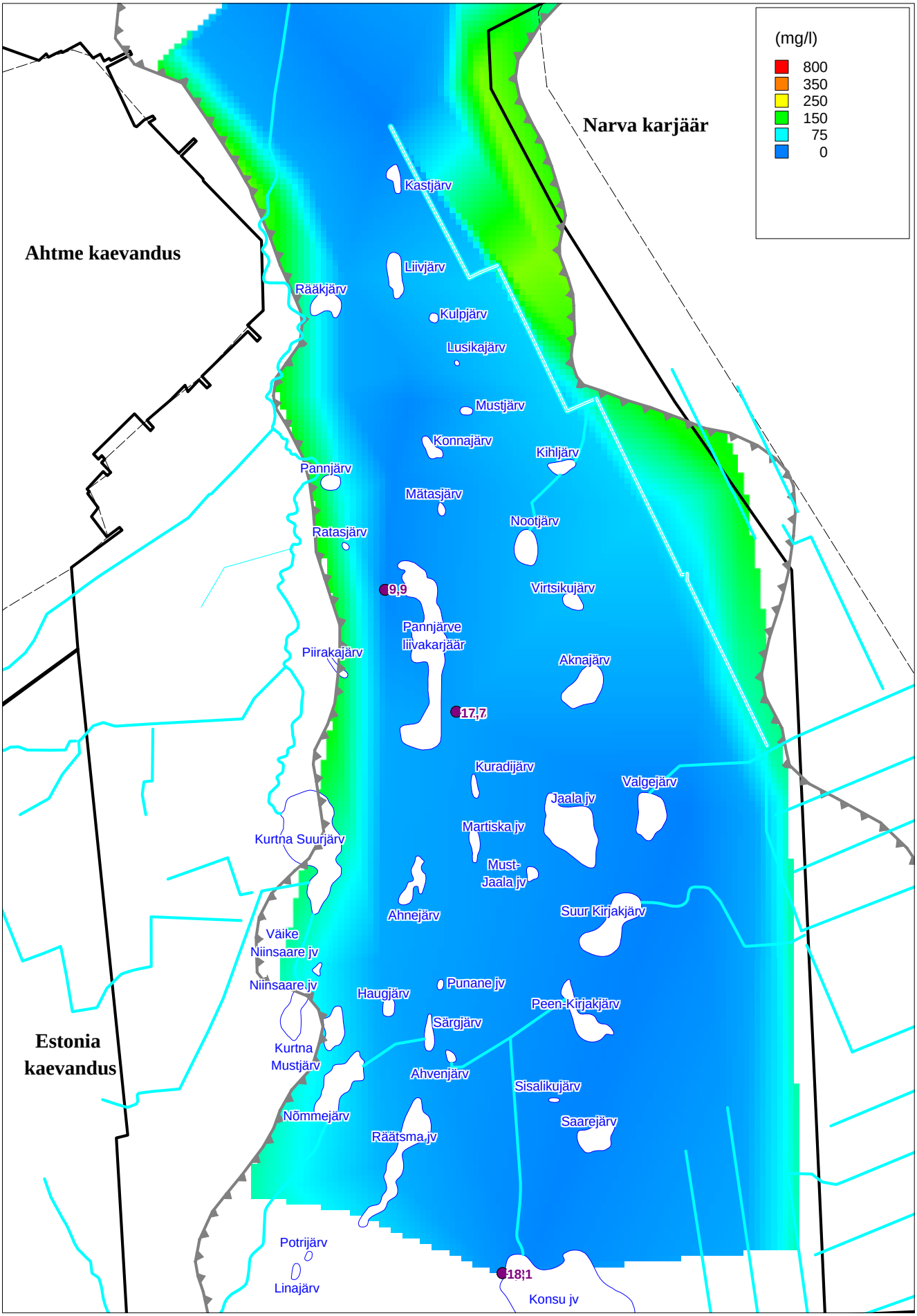
Joonis 24. Kvaternaari veekompleksi põhjavee sulfaatide sisaldus Vasavere piirkonna 1992. a.

Figure 24. The sulphate concentration of groundwater of Quaternary aquifer in Vasavere area in 1992.



Joonis 25. Kvaternaari veekompleksi põhjavee sulfaatide sisaldus Vasavere piirkonna 2002. a.

Figure 25. The sulphate concentration of groundwater of Quaternary aquifer in Vasavere area in 2002.



Joonis 26. Kvaternaari veekompleksi põhjavee sulfaatide sisaldus Vasavere piirkonna 2009. a.

Figure 26. The sulphate concentration of groundwater of Quaternary aquifer in Vasavere area in 2009.

A pathline is the path of a water particle (imaginary, of course) through the saturated groundwater in the subsurface. It is derived for an average seepage velocity of groundwater, variable in three-dimensional space. The travel time is the time period what a water particle resides in groundwater, while being “moved forward” by flowing groundwater. To give an idea about the travel time, for an average groundwater abstraction site in a shallow groundwater, the time that a water particle needs for its travel from the moment of infiltration into the soil till it is captured by a well screen ranges roughly between a few months and tens of years. However, in deep regional systems the travel time can easily be longer than many hundreds of years.

The simulation of pathlines and travel times can be done only after groundwater flow problems has been solved. Traditionally, pathlines and travel times are determined by a particle tracking technique.

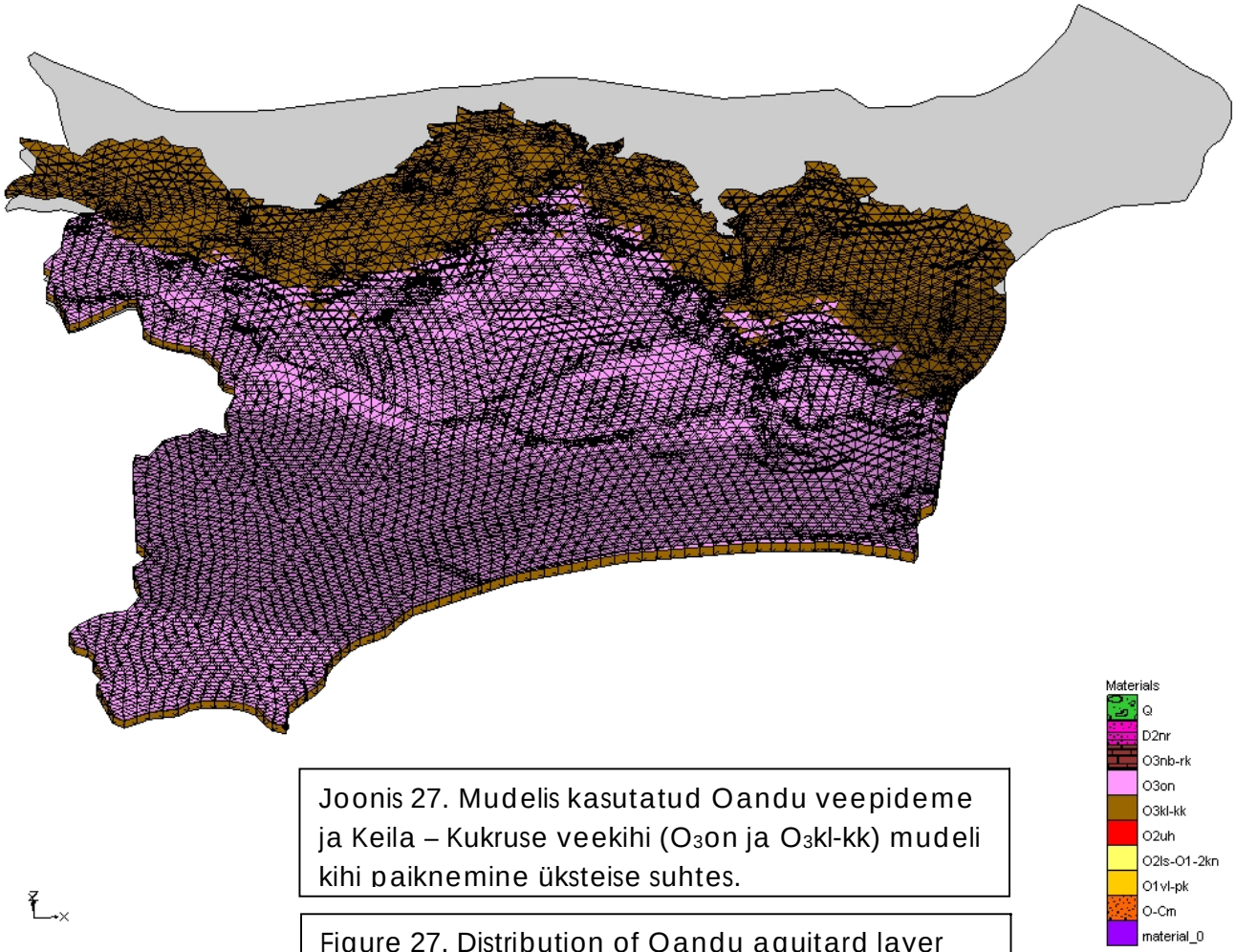
Because the groundwater flows very slowly (roughly metres to tens of metres per year), as compared to the water velocity in rivers, it takes a long period of time before the groundwater pollution can be detected. After all, even if we know the location source of pollution at the land surface and the pollution period, we do not know right away in which direction the pollution flows in the subsurface. Analogous, long periods of groundwater flow (often decades and longer) are, in general, needed for contaminants to be flushed from the contaminated subsurface. The process of a forced removal of contaminants (fast in time) is named *groundwater remediation*.

The transport of solute (contaminant) in groundwater is primarily affected by the following processes (mechanisms) (Kovar, 2008).

- *advection*, the movement of solute due to the average flow of groundwater. This mechanism is represented by pathlines and travel times,
- *dispersion*, the spreading of solute due to the mixing,
- *decay* of solute (its breakdown) due to chemical and bio(geo)chemical reactions between the solute and the medium, and the reactions between various solutes.
- *adsorption*, the process that expresses the (temporary) binding of solutes on the surface of grains constituting the porous medium.

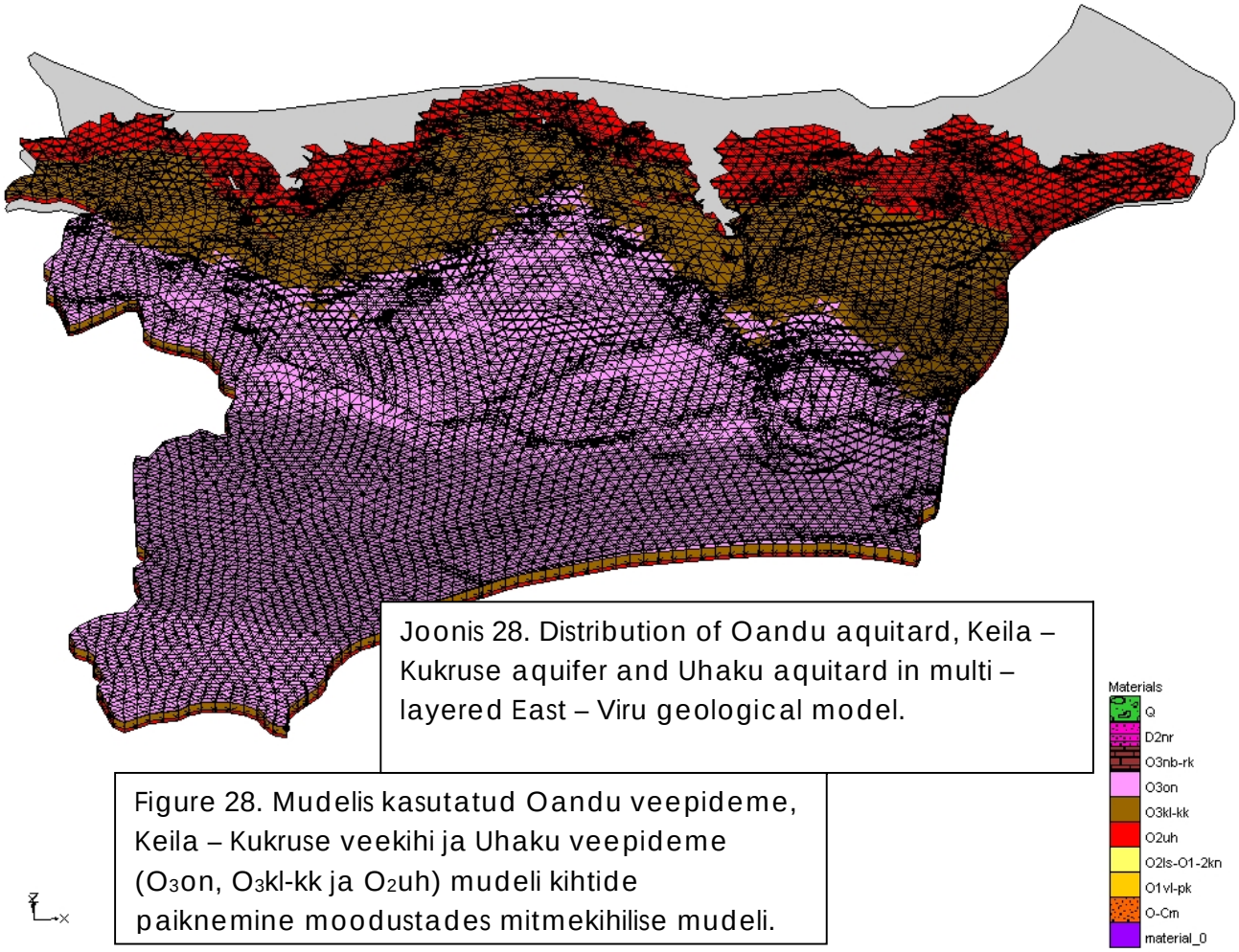
For each aquifer the abstraction rates have been imposed, as well as the groundwater recharge, computed from the evapotranspiration, soil characteristic and rainfall data. Exchange conditions with rivers have been assumed.

The qrid based geological solid model for simulation of pathlines and travel times has been created (Figures 29 - 31).



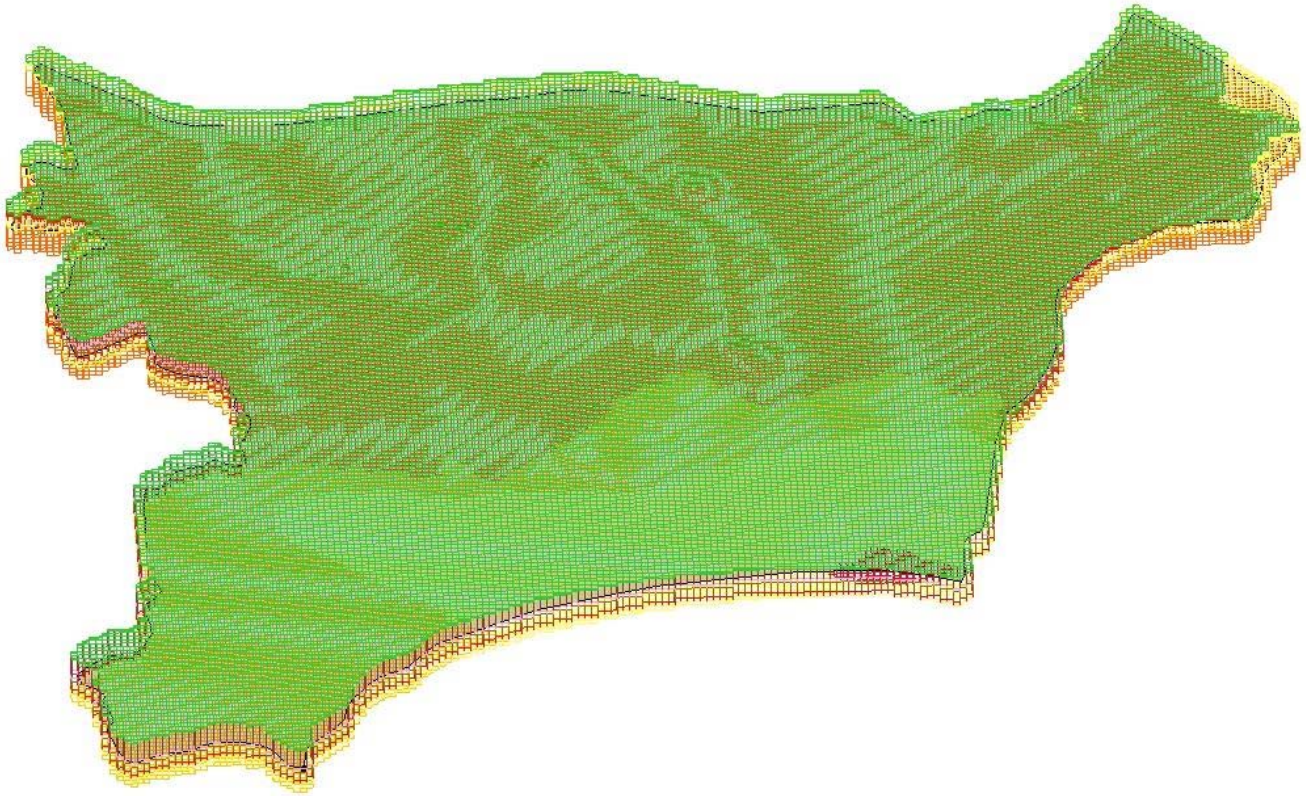
Joonis 27. Mudelis kasutatud Oandu veepideme ja Keila – Kukruse veekihi (O_3on ja O_3kl-kk) mudeli kihi paiknemine üksteise suhtes.

Figure 27. Distribution of Oandu aquitard layer and Keila – Kukruse aquifer layer in the East – Viru geological model.



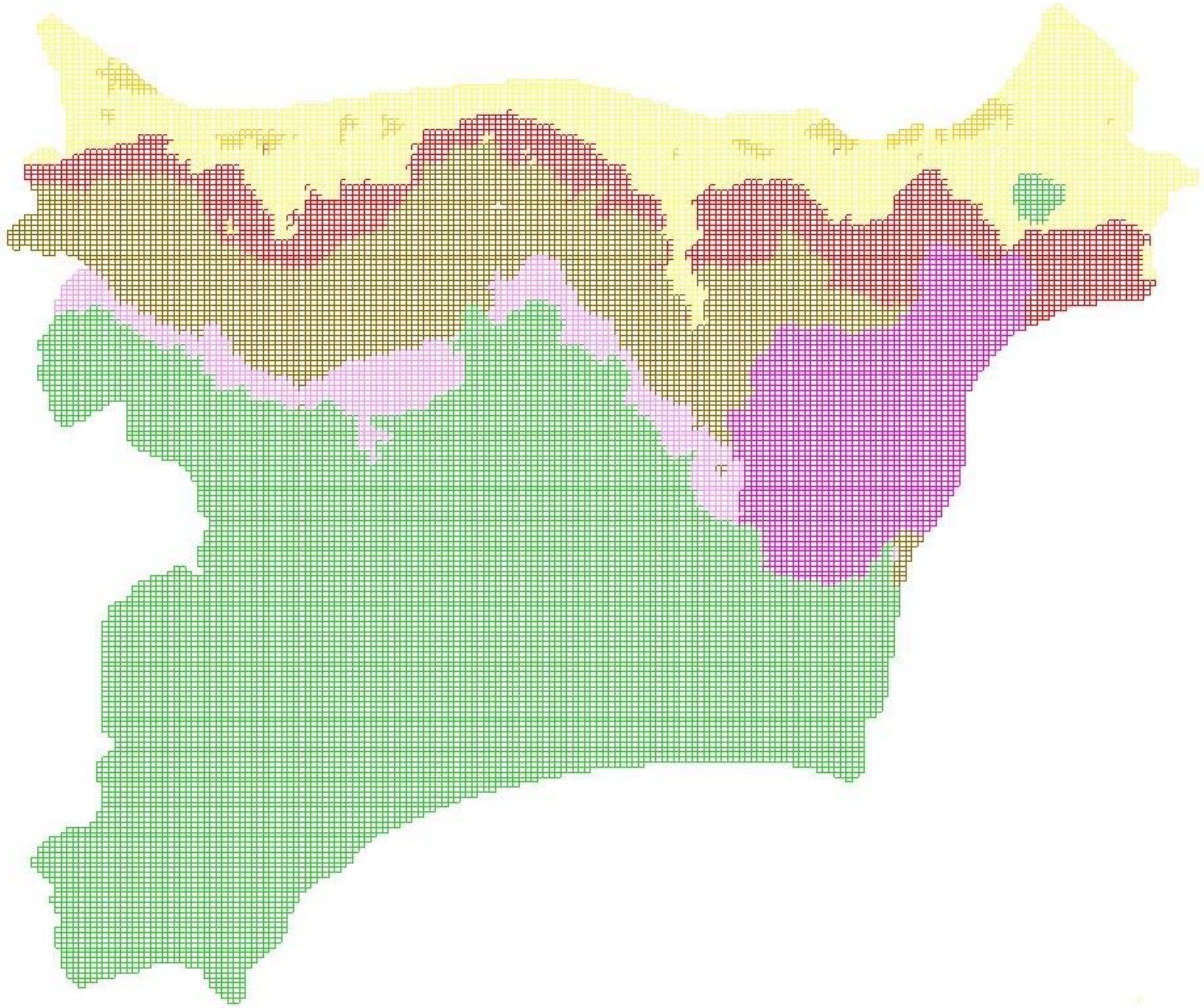
Joonis 28. Distribution of Oandu aquitard, Keila – Kukruse aquifer and Uhaku aquitard in multi – layered East – Viru geological model.

Figure 28. Mudelis kasutatud Oandu veepideme, Keila – Kukruse veekihi ja Uhaku veepideme (O_3on, O_3kl-kk ja O_2uh) mudeli kihtide paiknemine moodustades mitmekihilise mudeli.



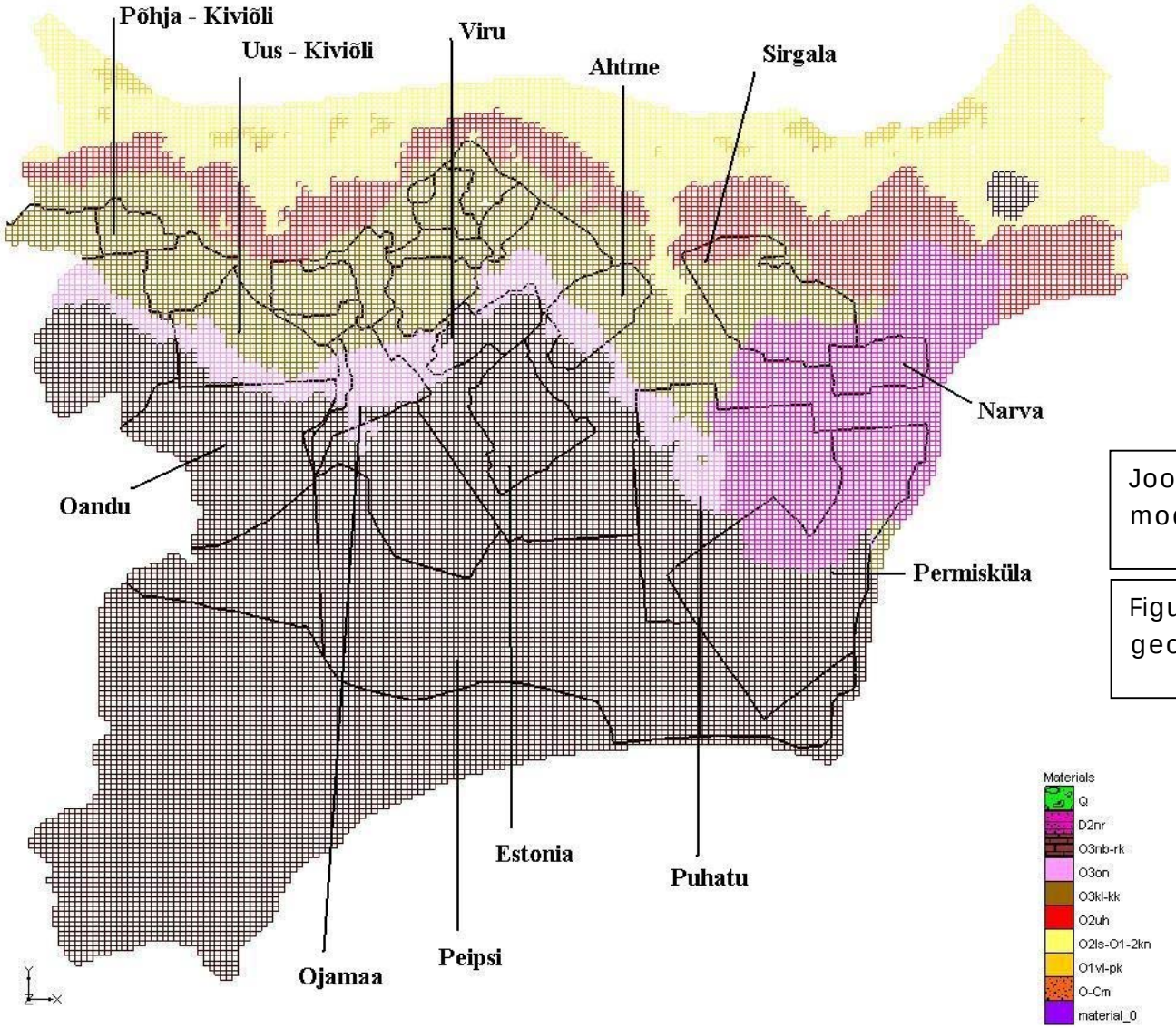
Joonis 29. Modelleerimiseks vajalikule, ruudustiku kujule viidud Ida-Virumaa mudel.

Figure 29. A grid based model, generated MODFLOW data from East-Viru solid model.



Joonis 30. Modelleerimiseks vajalikule ruudustiku kujule viidud Ida-Virumaa kolmemõõtmeline geoloogiline mudel.

Figure 30. For grid based modeling, generated MODFLOW geological data from East-Viru solid model.



Joonis 31. Põlevkivi väljade paiknemine modelleerimise ruudustikul.

Figure 31. Oil Shale field borders on MODFLOW geological data.

4.2. Development of regional model

4.2.1. Archival Data Quality Control and Standardization

Geologic and hydrogeologic data were integrated in a database Access. All records in the database are spatially referenced by coordinates and by elevation. The database is largely composed of archival boreholes assembled by geological mapping and exploration of oil shale. Data for a total of 2,738 boreholes and wells from groundwater cadastre of EGK was used. Since the subsurface data are of variable reliability, they were assigned a weighting factor using a step-by-step data management approach, which include data documentation and quality control praedures.

The next step was to identify boreholes described using accepted scientific methodology and for which the original documentation was available. The suitable for model are boreholes with depth more than bottom of Pakerort stage.

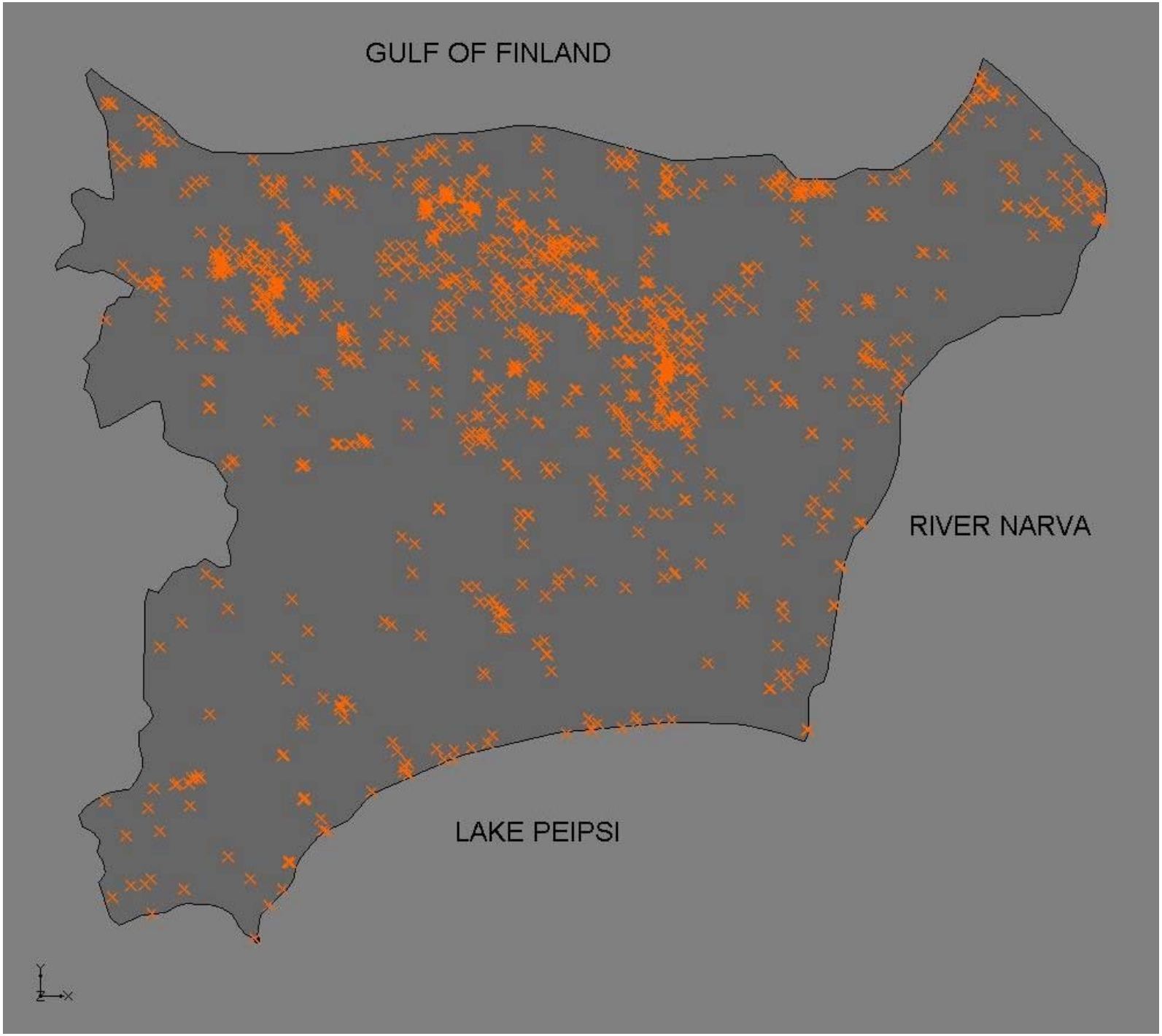
All together the model consists from 558 boreholes and 71 virtual boreholes, which were needed to create the boundaries of Vasavere buried valley and to define stratigraphical boundaries of different layers. The location of wells used for stratigraphical model is presented in Figure 4.2.1.

4.2.2. The choice of the modeling tool

GIS are powerful tools, which allow for spatial analyses and representations of georeferenced data. These tools have proved their usefulness in hydrogeology over the years but standard multi-layered systems are quite limited for modeling, visualizing and editing subsurface data and geologic objects and their attributes.

A discrete modeling approach was chosen to construct the geologic model. The 3D geomodeling system Groundwater Modeling System (GMS) was used on a PC with Windows XP (Microsoft) platform to carry out this part of the work. This software, which is developed by Geological Survey of United States is specifically designed to construct and analyze geologic and hydrogeologic objects and their properties.

GMS v. 6.5 is the most sophisticated and comprehensive groundwater modeling software available. Used by thousands of people at different agencies, private firms and international sites in over 90 countries, it has been proven to be an effective and exciting modeling system. GMS provides tools for every phase of a groundwater simulation including site characterization, model development, calibration, post-processing and visualization. GMS supports both finite-difference and finite-element models in 2D and 3D including MODFLOW 2000, MODPATH, FEMWATER and etc.



Joonis 4.2.1: Puurkaevude võrgustik Ida-Virumaal.

Figure 4.2.1: Location of wells used for modelling.

4.2.3. Building geologic cross-sections

Prior to the construction of the model surfaces, one of the most challenging aspect of the modeling task was to adequately correlate borehole attributes to a given stratigraphic unit (Figure 4.2.2) since the known composite stratigraphic sequence is usually in complete at most sites, correlation must be made carefully. Since it is more natural and easer for the human mind to understand data relationships in 2D, the initial correlation and interpolation were made using 2D vertical working planes (Figure 4.2.3).

4.2.4. Surface modeling

A Triangular Irregular Network (TIN) module is used for surface modeling (Figure 4.2.4). A TIN was created from topographic data and every pirece of surface information was draped onto that TIN. TINs are formed by connecting a set of XYZ wells with edges to form a network of triangles. The surface is assumed to vary in a linear facing across each triangle. Several TINs can be modeled at once in GMS. A TIN may be created within GMS 6.5 by 4 different methods. In this model is used the method of Natural neighbour. The three-dimensional surface in two-dimensional image is presented on Figure 4.2.5.

4.2.5. Solid Module

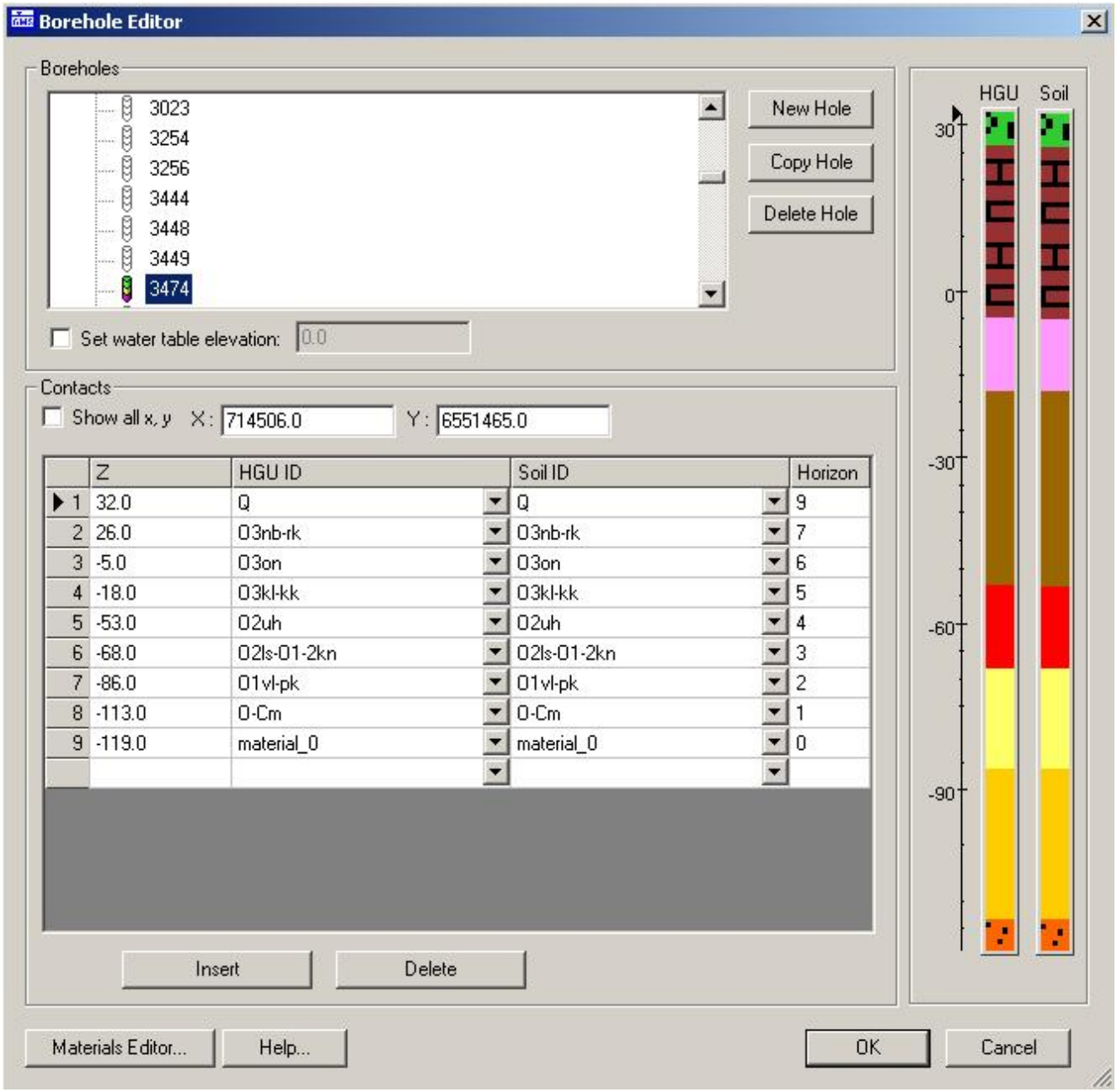
The solid module of GMS is used to construct three-dimensional models of stratigraphy using solids (Figure 4.2.6). Once such a model is created cross-sections can be cut anywhere on the model and the solid model can be shaded to generate realistic images. The created stratigraphical model can also be used to define layer data for MODFLOW models using the Solids → MODFLOW command.

4.2.6. Creating of the Horizon Coverage

The created Horizon Coverage corresponds more or less to geological and hydrogeological maps of East-Viru County (Figure 2.4.7). In some places the used in model triangulars are too large to create more narrow structures (buried valleys).

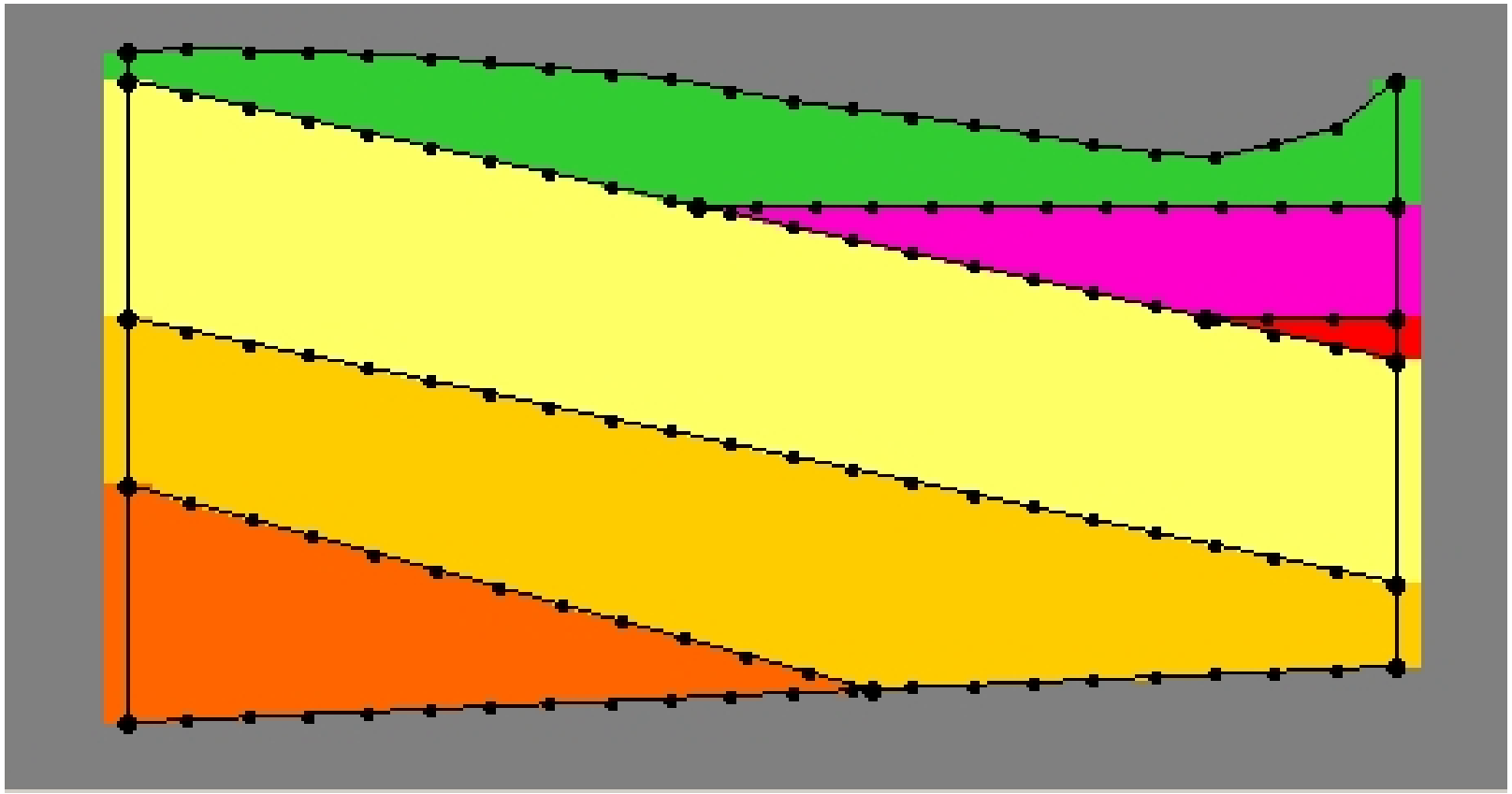
4.2.7. Cutting Cross-Sections

The created Horizon Coverage is possible to use for compiling of cross-sections. The top of cross-section is defined by elevation of wells above sea level, the lower plane is determinated 70 m below sea level what correspond to bottom of Uhaku aquitard at Lake Peipsi (Figure 4.2.8).

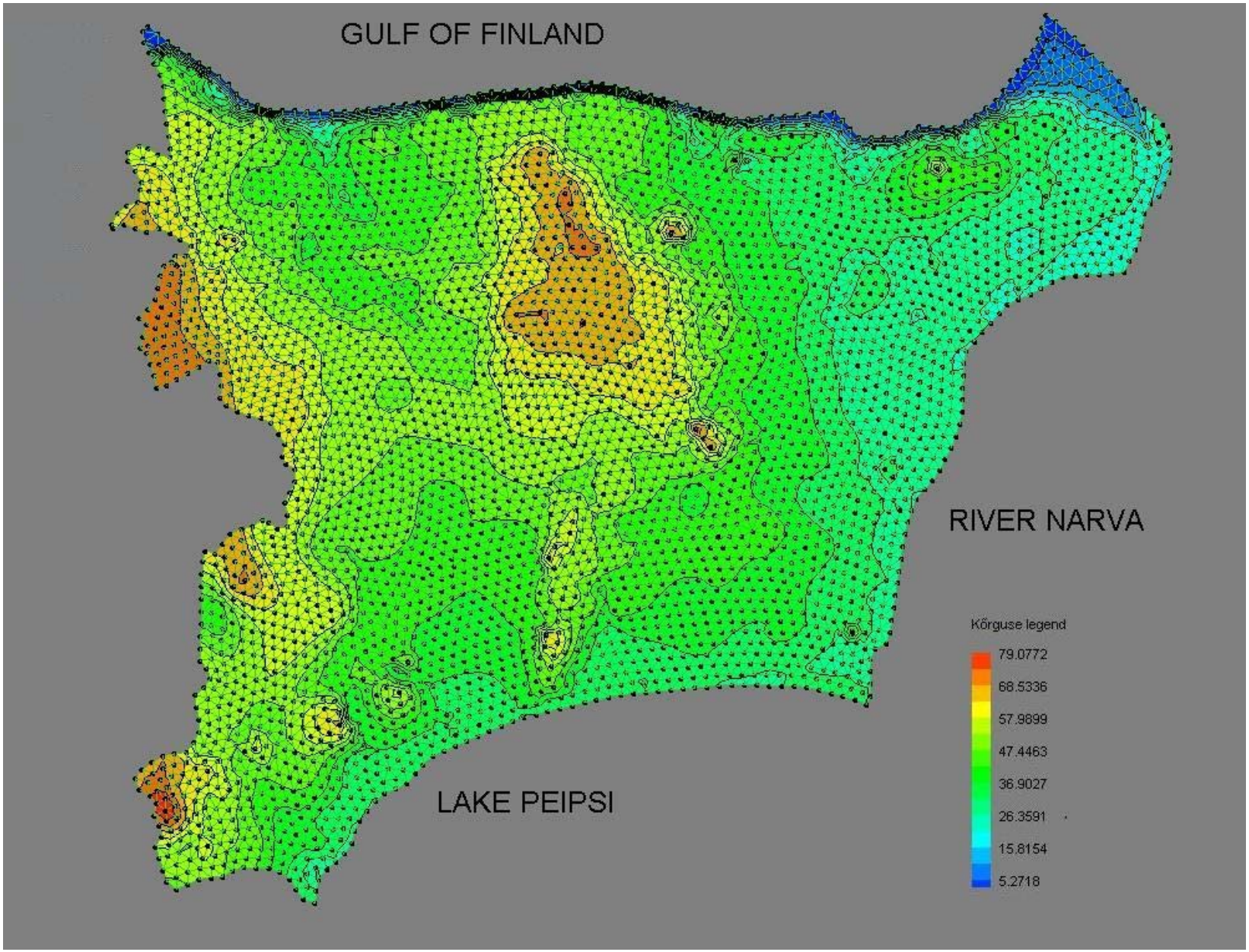


Joonis 4.2.2. Puurkaevu visualiseeritud kujutis GMS 6.5 programmi kasutades.

Figure 4.2.2. Visualization of horizons by GMS version 6.5.

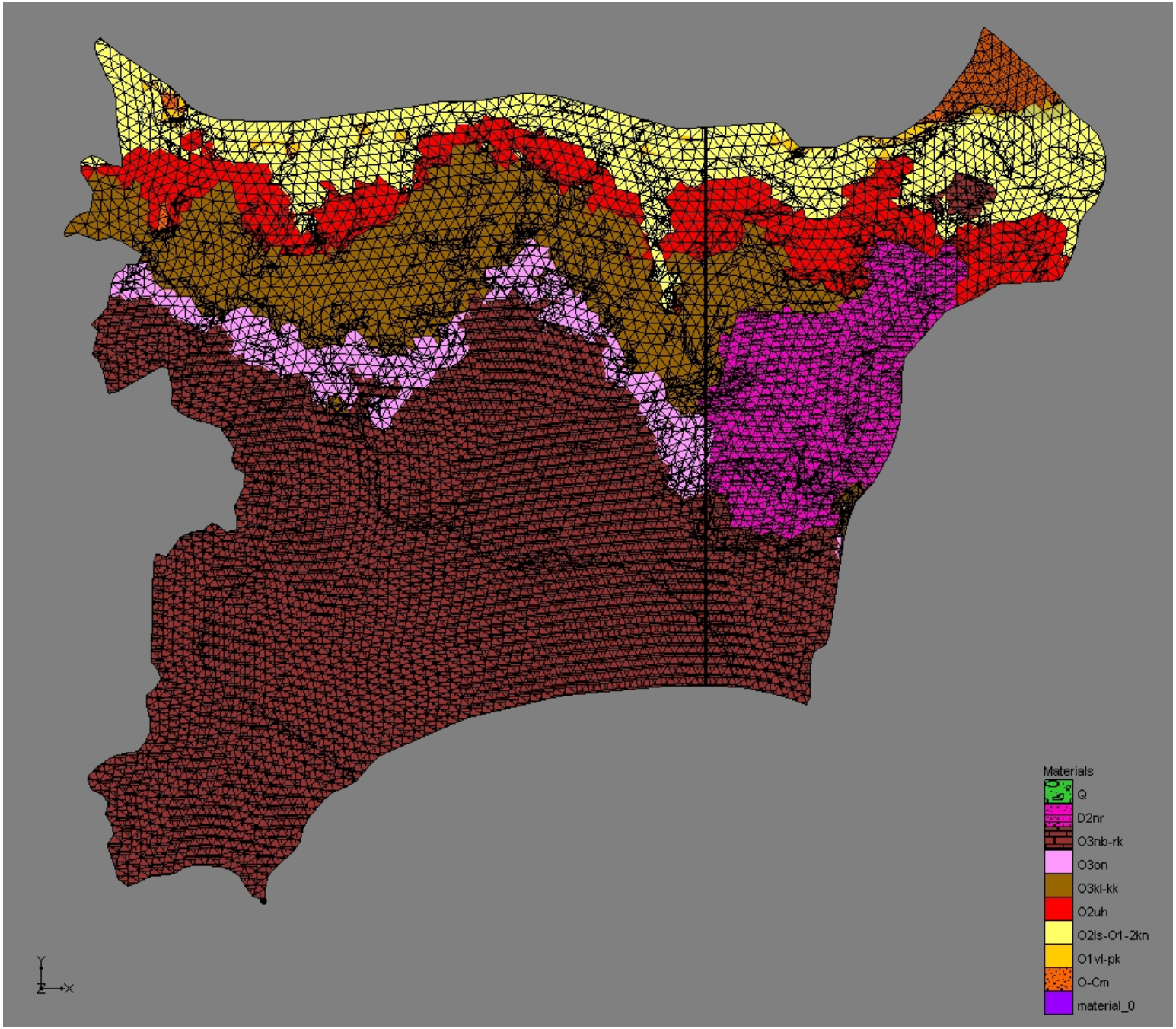


Joonis 4.2.3. Näidis kahte puurkaevu ühendava seose kohta.
Figure 4.2.3. Creation of connections between two boreholes.



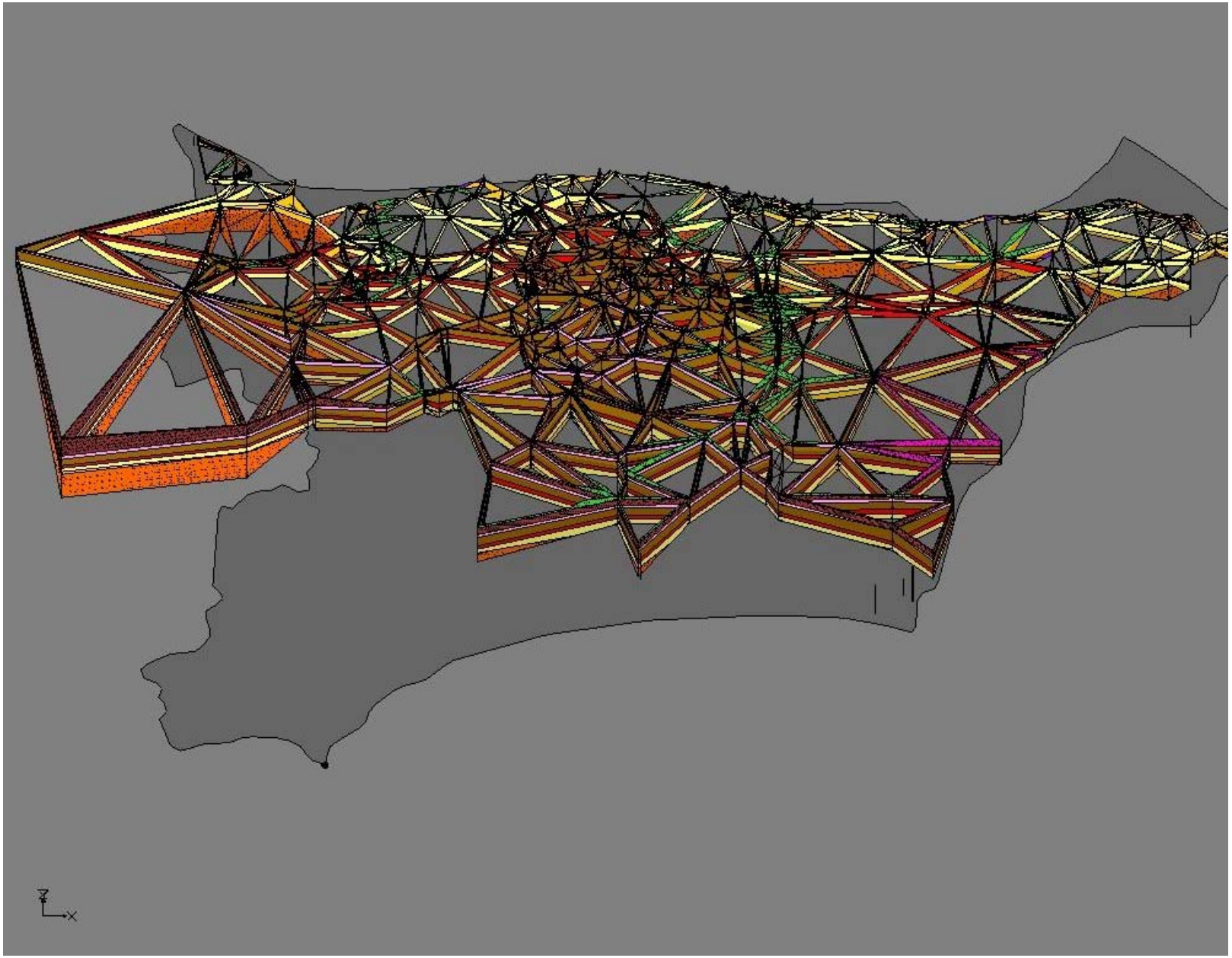
Joonis 4.2.4. Puurkaevude kõrgusi kasutades moodustatud pinnareljeef.

Figure 4.2.4. Land surface by elevation of used wells.



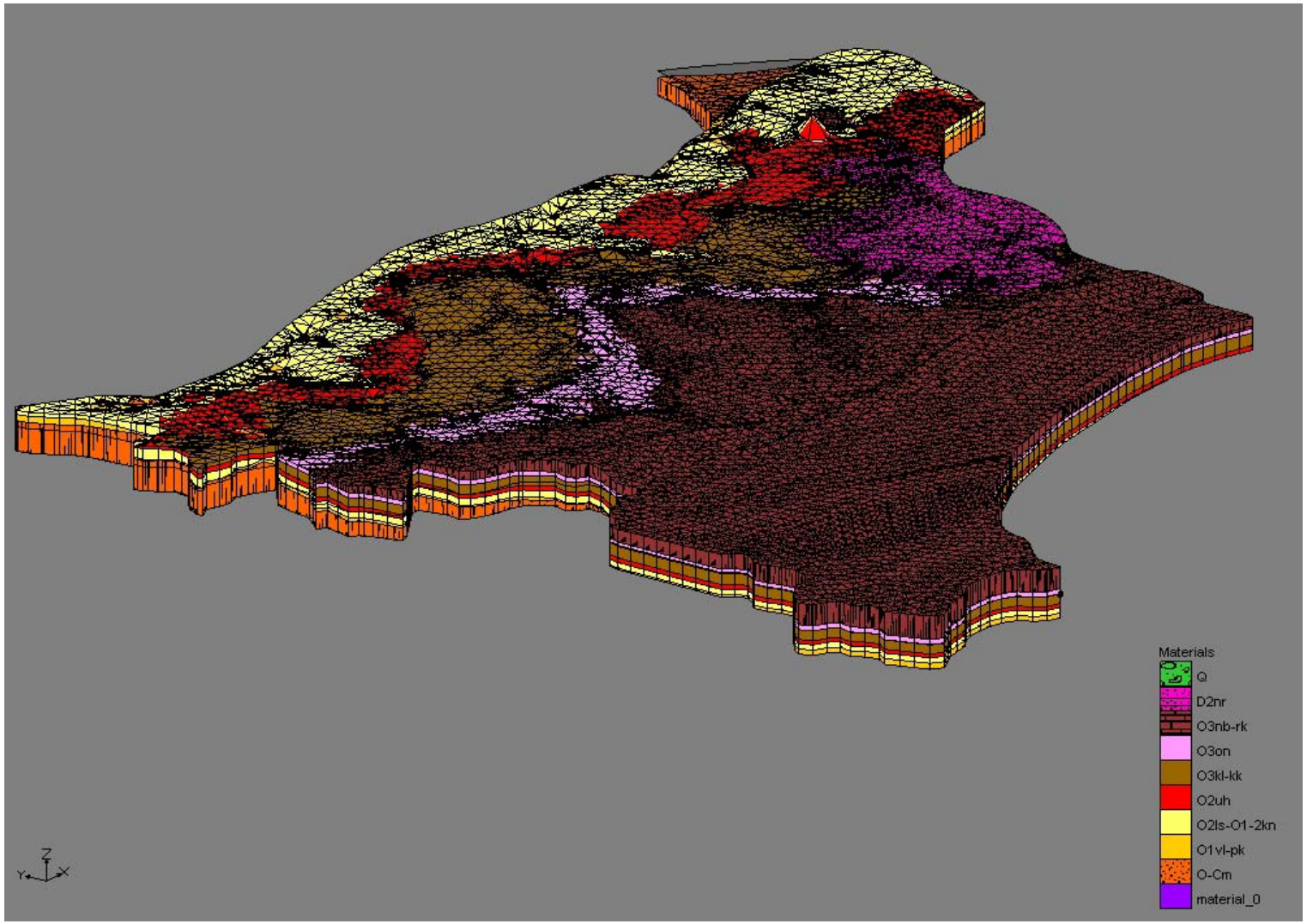
Joonis 4.2.5. Ida-Virumaa hüdrogeoloogilise mudeli pind pealt vaates.

Figure 4.2.5. The horizon coverage of East – Viru model from top.

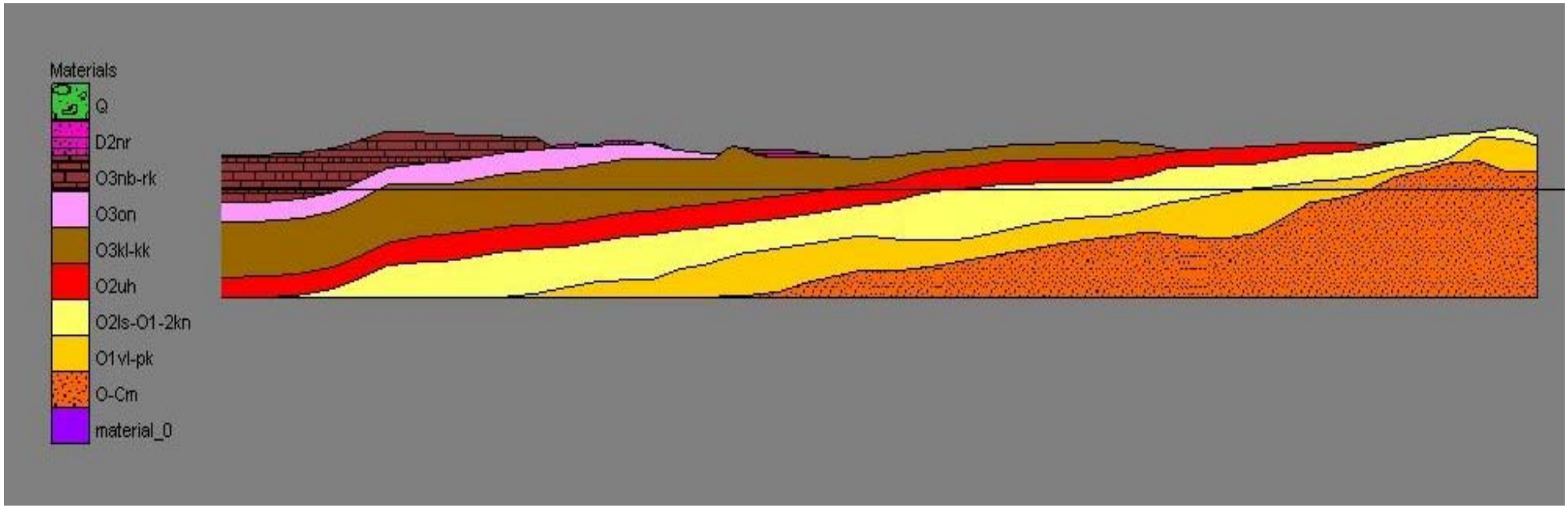


Joonis 4.2.6. Ida – Virumaa puurkaevude läbilõikeid ühendavate ühenduste võrgustik.

Figure 4.2.6. Creation of three-dimensional cross-section.



Joonis 4.2.7. Ida – Virumaa hüdrogeoloogiline mudel lääne – ida suunalises külgvaates.
Figure 4.2.7. East – Viru model from the West – East Viru



Joonis 4.2.8. Hüdrostratigraafilise mudeli läbilõige.
Figure 4.2.8. Hydrostratigraphical cross-section of East – Viru model.

4.2.8. Hydraulic conductivity

The data of 235 pumping tests in the oil shale region have shown that the lateral conductivity of Ordovician carbonate rocks near the surface is predominantly between 5–300 m/d, while at a depth of 80–100 m it is only 0.1 m/d (Риет, 1974; Riet, 1976).

According to the water budget calculations, the transversal conductivity of the layers between the lateral water conducting zones is 10^{-5}–10^{-2} m/d (Валлнер, 1980; Йыгар, 1983). These interlayers serve as weak or medium aquitards confining the local aquifers of different range.

In the region of oil shale mines with plentiful experimental data, the following aquifers and aquitards can be distinguished with different hydraulic conductivity and transmissivity. The hydraulic conductivity of Nabala–Rakvere aquifer is usually 2.0–7.0 m/d, in Keila–Kukruse aquifer – 0.70–143 m/d, predominantly – 14–26 m/d and in average 16 m/d. The hydraulic conductivity of Lasnamäe–Kunda aquifer is rather low – 0.3–2.5 m/d. The lateral conductivity of the Ordovician–Cambrian aquifer mostly ranges from 2 to 3 m/d. The results of calculation of hydraulic parameters are presented at Table 1.

By aquitard has meant a low-permeability unit that can store groundwater and also transmit it slowly from one aquifer to another. In the Ordovician aquifer system in oil shale region between Nabala–Rakvere and Keila–Kukruse aquifers is distinguished Oandu aquitard, between Keila–Kukruse and Lasnamäe–Kunda aquifer – the Uhaku aquitard and between Lasnamäe–Kunda and Ordovician–Cambrian aquifers – Lower-Ordovician aquitard. All aquitards are characterized by transversal conductivity generally less than 1.0 m/d.

Local hydrogeological conditions mainly depend on the hydraulic conductivity of rock, on the thickness of overburden and on the seasonal variation in precipitation. The hydraulic conductivity is mainly determined by a degree of fracturing and by local karst. As a rule, the hydraulic conductivity of rocks is at its highest near the surface and loweres gradually downwards.

The lateral conductivity in the carbonate bedrock is variable: 10–50 m/d at the topmost 20 m; 5–8 m/d at depth of 20–50 m and only 1–2 m/d at a depth of 50–100 m. The lateral conductivity at deeper strata does not usually exceed 1 m/d, although occasionally strata with considerably higher conductivity can be found.

4.2.9. Water balance of catchment areas

In Estonia groundwater is recharged from rain- and meltwater percolating through unsaturated soils (seepage flow). Mean annual precipitation in East-Viru River Basins is 500–750 mm. The net infiltration is calculated as seepage flow (percolation) minus evaporation from the

zone of saturation or capillary fringe. By water balance calculations the net infiltration is equivalent to groundwater runoff from the total river discharge. The components of water balance are presented on the Table 2.

4.2.10. Arcivement of the potentiometric map

According to the data of groundwater cadastre and result of groundwater monitoring the potentiometric map of Keila–Kukruse aquifer was compiled (Figure 4.2.9). The simulated configuration of potentiometric surface is presented in Figure 4.2.10. The cross-sections with potentiometric surface of Keila–Kukruse aquifer are presented in Figure 4.2.11 and 4.2.12.

4.2.11. Definition of the boundaries conditions

According to the piezometric maps and the hydrogeologic knowledge the choice of the boundaries conditions type was applied to each aquifer (flow condition, constant head condition, known flux condition). In addition the type of bounder conditions to be applied at the surface of the model to take into account the lakes and the rivers must be identified according to the available functionalities of hydrodynamic software (Figure 4.2.13).

1. Evaluation of the recharge flux in each aquifer

The recharge flux is an input parameter of the hydrodynamic model. This parameter must be calculated on the basis of weather data (rain, potential evapotranspiration, snow etc.) and behavior of the piezometric time series.

For each aquifer include in the flow model, it would be necessary to determine the recharge zones and the average recharge values to be apply to the model. The aquifer's recharge values are not often well known, this parameter remains a calibration parameter in the flow model.

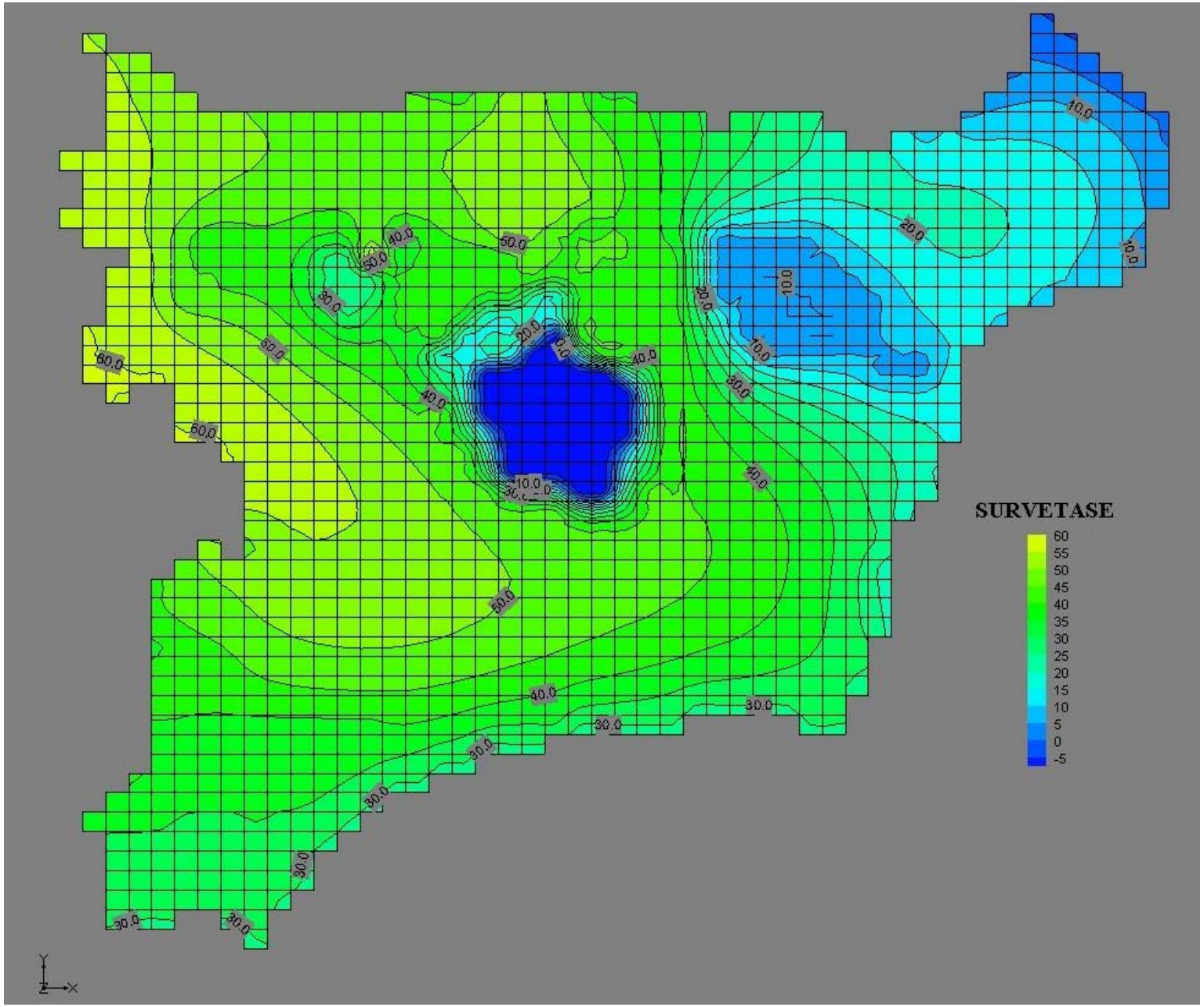
2. Preparation and integration of the water volume abstraction data into the flow model for each modeled aquifer.

The data of volumes of water intake by type of use (drinking water supply and inflow into mines and opencasts) and by aquifer are prepared and can be extracted directly from database.

4.3. Building of local groundwater models

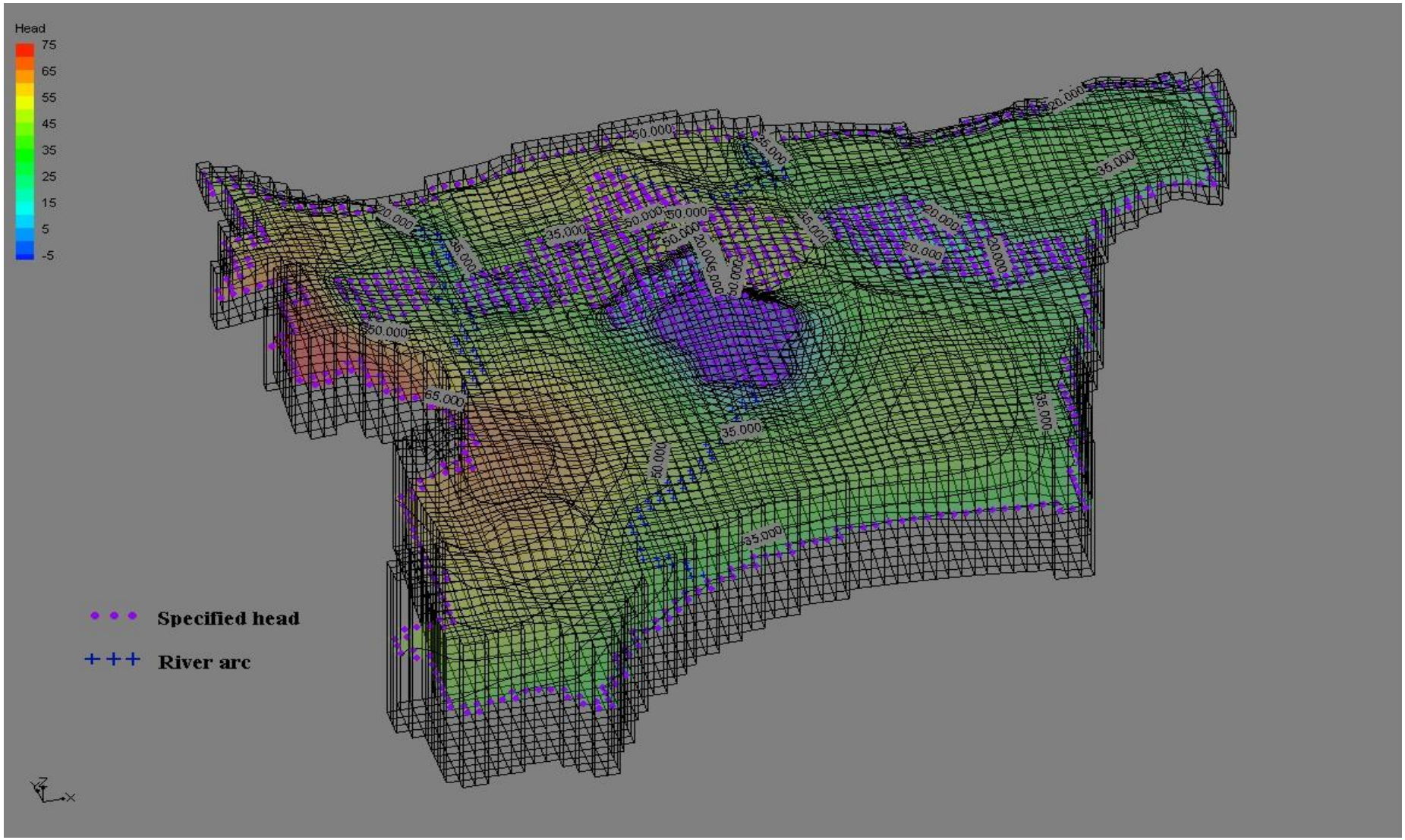
Case study 1

At present the estimated groundwater flow from Ahtme mine to Estonia mine make up 13.4 thousand m^3/d (Figure 4.3.1). It is expected that the Estonia mine will be closed in 2030. After closing the groundwater will more intensively flow from Ahtme mine to Estonia mine and there exists the risk that from side of buried valley and Vasavere groundwater intake will be flow to



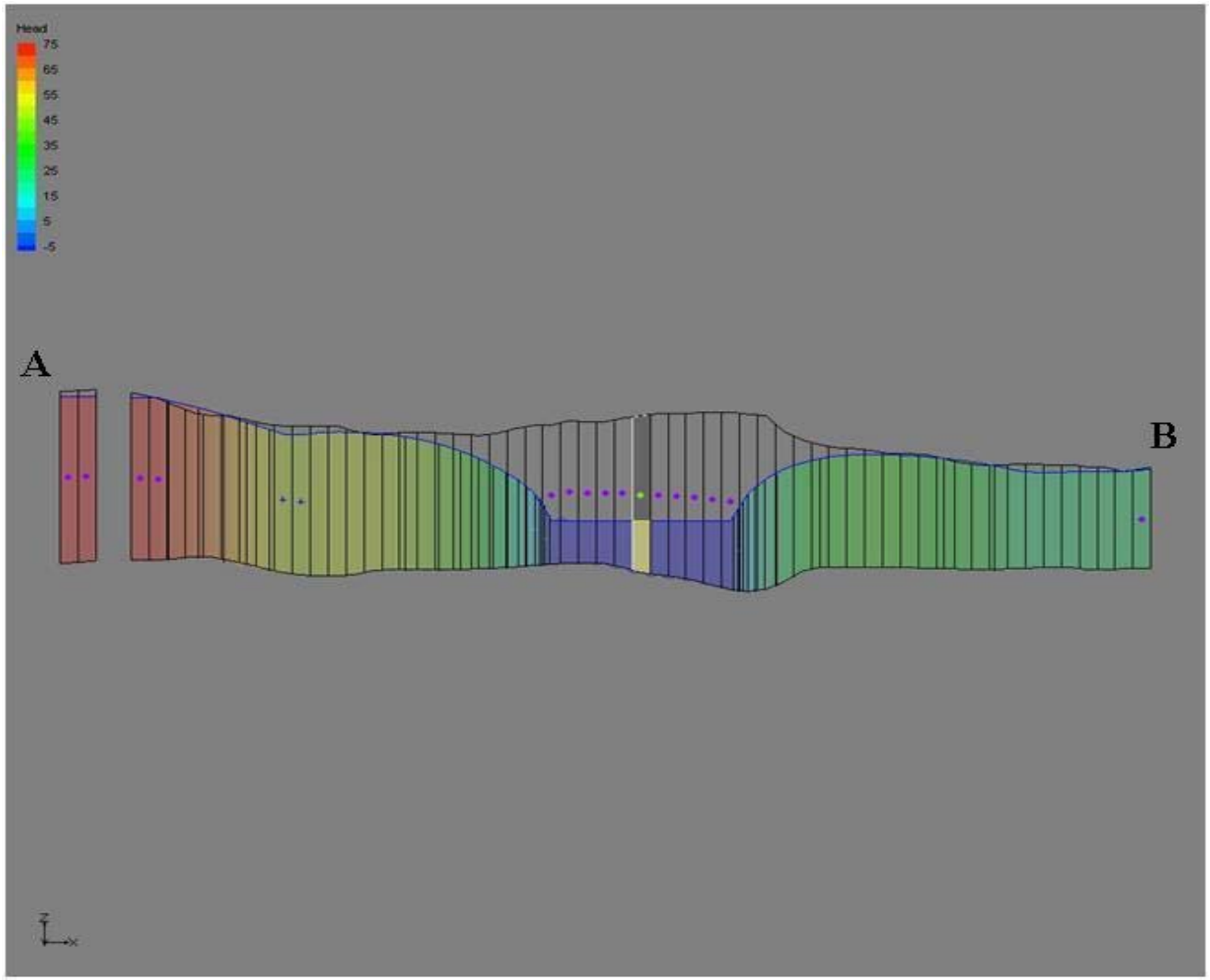
Joonis 4.2.9. Ordoviitsiumi veekompleksi põhjaveetaseme modelleeritud seis 2009. aastal.

Figure 4.2.9. Ordovician aquifer modeled groundwater level in year 2009.

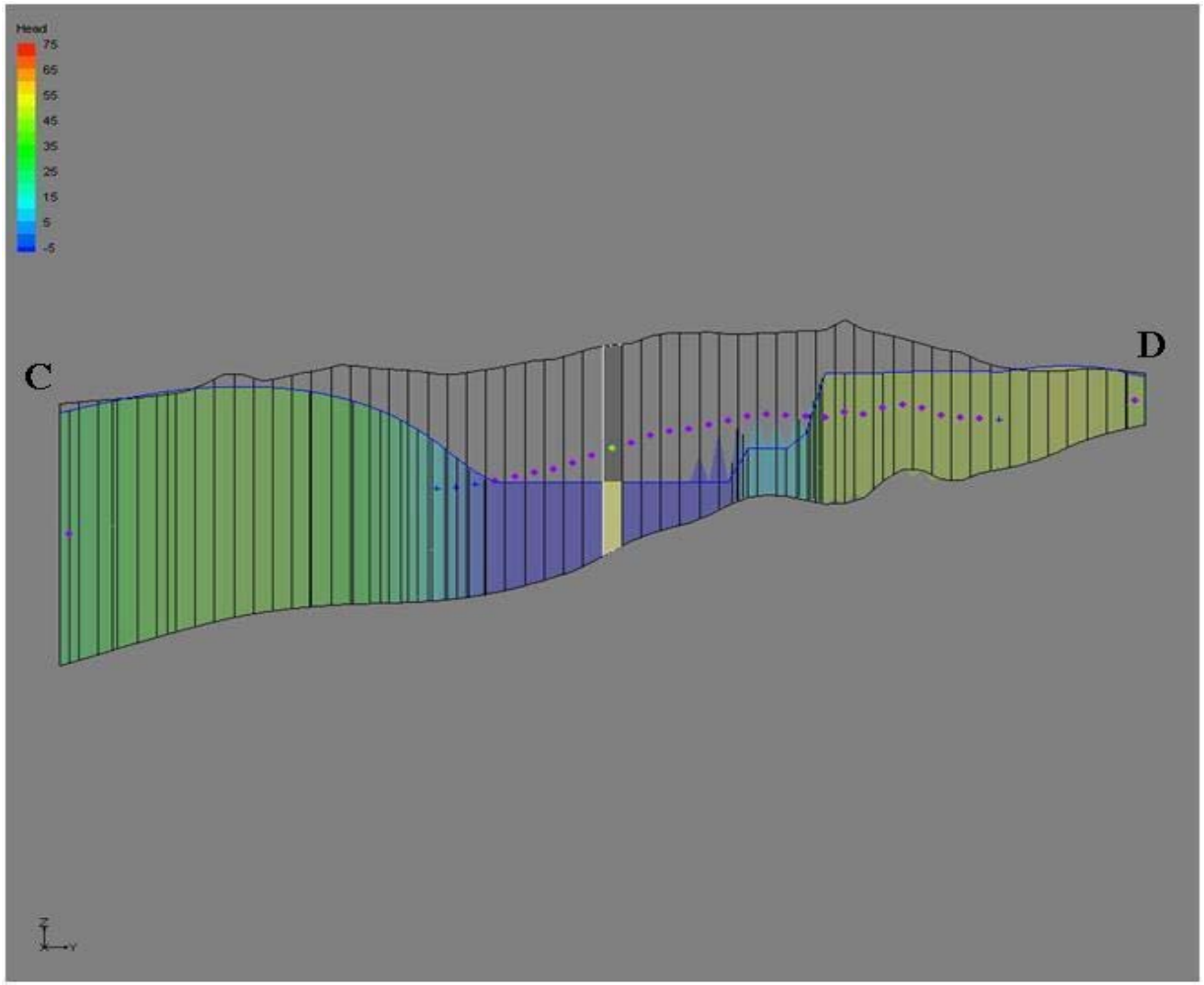


Joonis 4.2.10. Modelleeritud potentsiomeetriline pind.

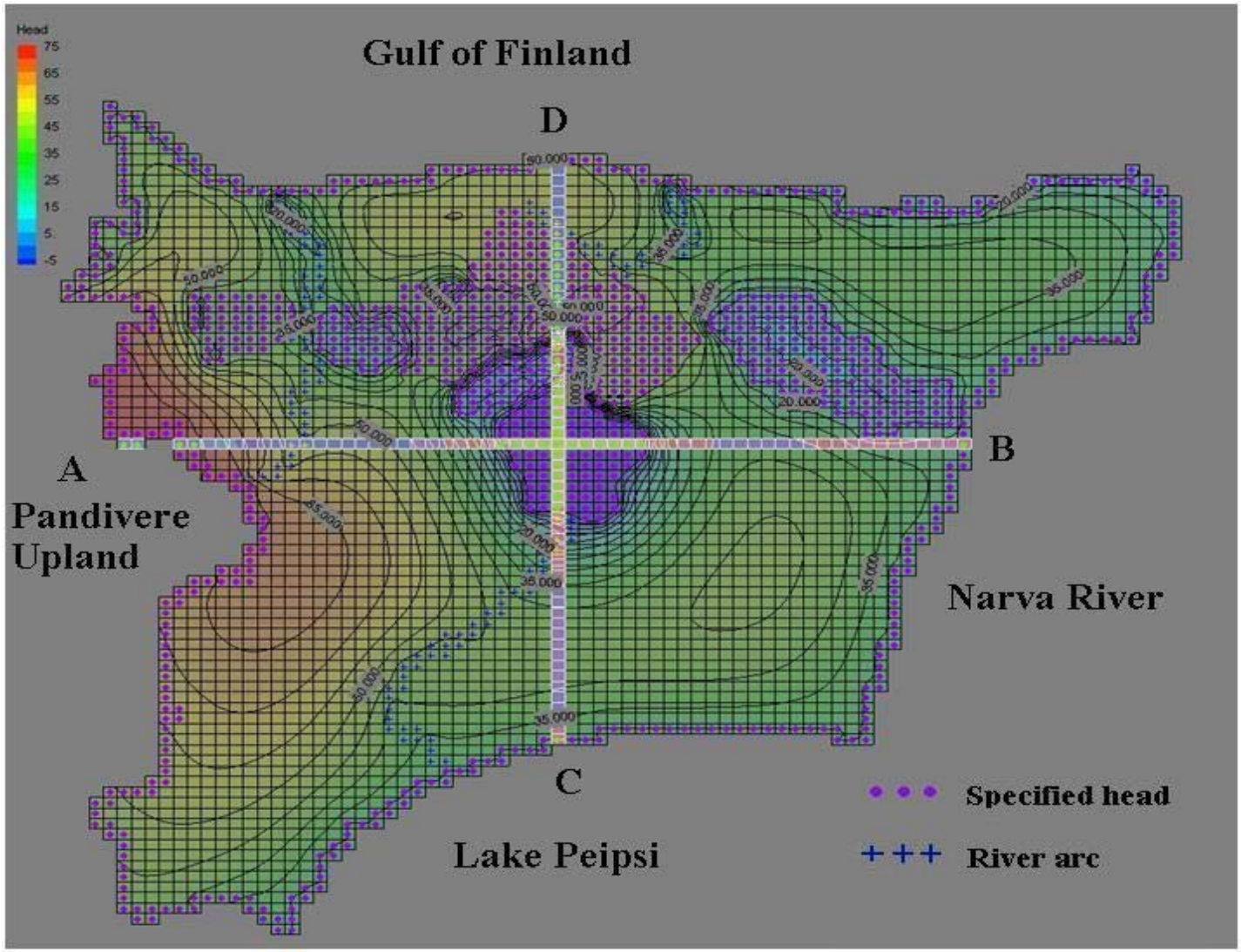
Fig 4.2.10. Simulated configuration of potentsiometric surface.



Joonis 4.2.11. Läbilõige lõigul AB koos Keila – Kukruse veekihi potentsiomeetrilise pinnaga.
Fig 4.2.12. Cross – section AB with potentiometric surface of Keila – Kukruse aquifer.



Joonis 4.2.11. Läbilõige lõigul CD koos Keila – Kukruse veekihi potentsiomeetrilise pinnaga.
Fig 4.2.11. Cross-section CD with potentiometric surface of Keila – Kukruse aquifer.



Joonis 4.2.13. Piiri tingimused ja jõed

Fig 4.2.13. Boundary conditions and river arcs

Ahtme mine groundwater in amount of 4.3+0,9 thousand m³/d (5200 m³/d; Figure 4.3.2). To preserve the proved reserves of Vasavere intake, it will be necessary to keep the water level in Ahtme mine at 42 m asl. It means also that volume of Ahtme mine water should have replenish with the amount of outflow from Ahtme mine to Estonia mine. For replenishment is possible to use water from pumping station No 13 of Estonia mine.

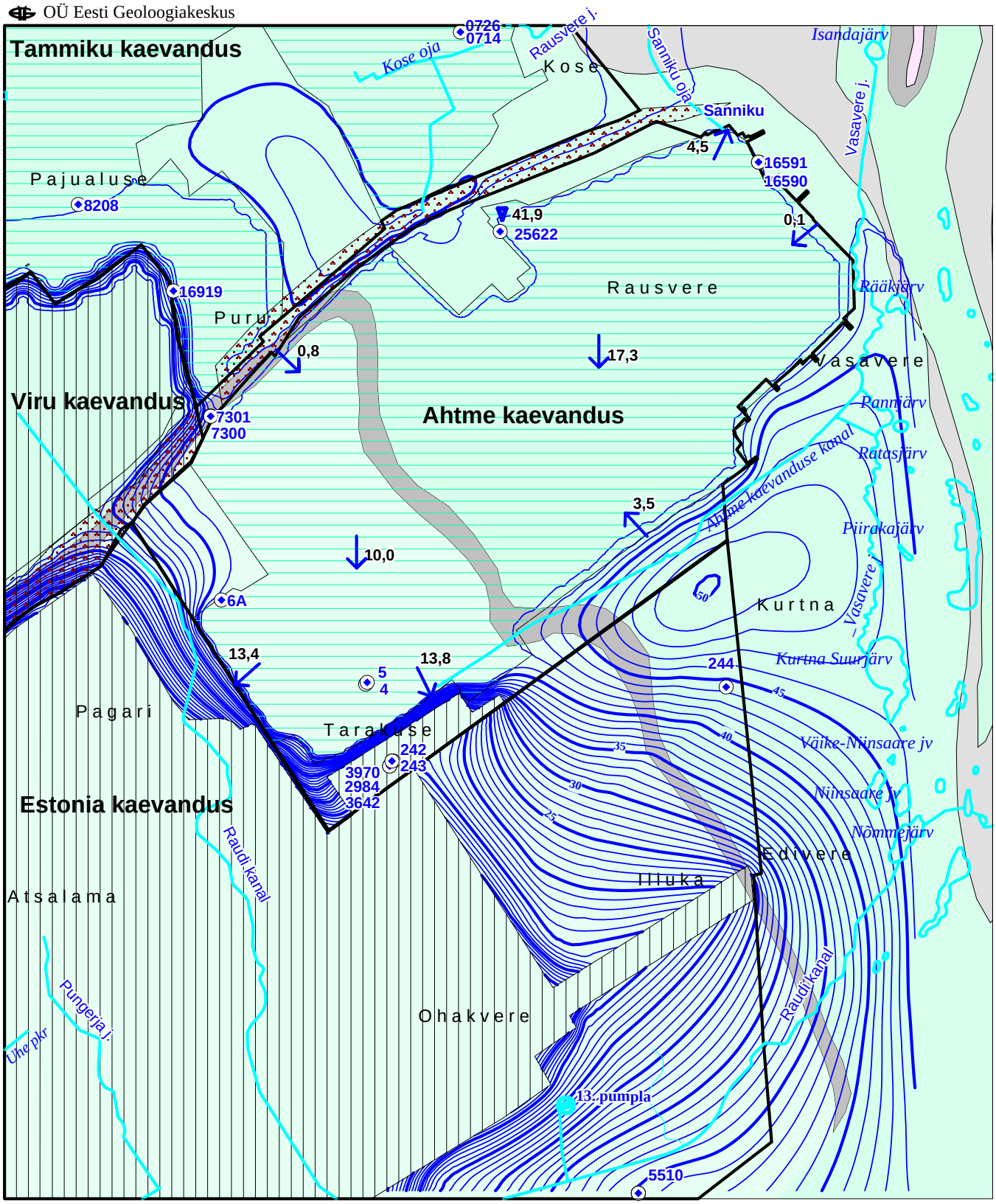
Case study 2

Mining is considerably influenced by hydrogeological conditions. 14–18 m³ of groundwater is pumped out per ton of mined oil shale. The major source of mine water is the Keila–Kukruse aquifer. After some next years the Aidu opencast and Viru mine excavating come to an end and there is a need to open new mines. Almost a hundred-year history of oil shale mining in Estonia has been exhausted and used up the best parts of oil shale. The best conditions to continue oil shale mining is in Uus-Kiviõli exploration field. The study surveys and forecasts have been made in the past. Through the years has made the groundwater monitoring, which is planned to automatize in the frame of this project. The local population is worried about the noise associated with the production of the wells and the potential loss to dryness, which most likely involves with mining activity. The compiled groundwater model of Uus-Kiviõli mine is trying to use the best available solutions to ensure minimal damage in the groundwater status. In future the drawdown of groundwater level around Uus-Kiviõli mine will depend also from changes of groundwater status in Ojamaa mine field area (Figure 4.3.3).

Numerical hydrogeological model was worked out to forecast how the groundwater state will be influenced by following factors: the closing of Aidu quarry in 2012, its filling with water up to absolute altitude 42 m and opening of new perspective mine Uus-Kiviõli in 2013.

Hydrogeological model of area 389,11 km² catches until Sonda in south, Sompa mine in east, Kohtla River in north and the line of Koolma village in south. The cross-section of the model consists of 7 layers from Quaternary aquifer system till Lasnamäe–Kunda aquifer. The model step is 100 m.

As the basis of numerical hydrogeological model serve the results of geological and hydrogeological works done at previous years which were improved with measurements at new hydrological profiles. The initial position of the groundwater level in Uus-Kiviõli mine area is water level in Aidu opencast on 42 m a.s.l. The simulated contour lines after closing of Aidu opencast are presented in figure 4.3.4. The initial position of groundwater was shown by contour lines of the potentiometric surface.



242 - vaatluskaev ja selle number
monitoring well and number

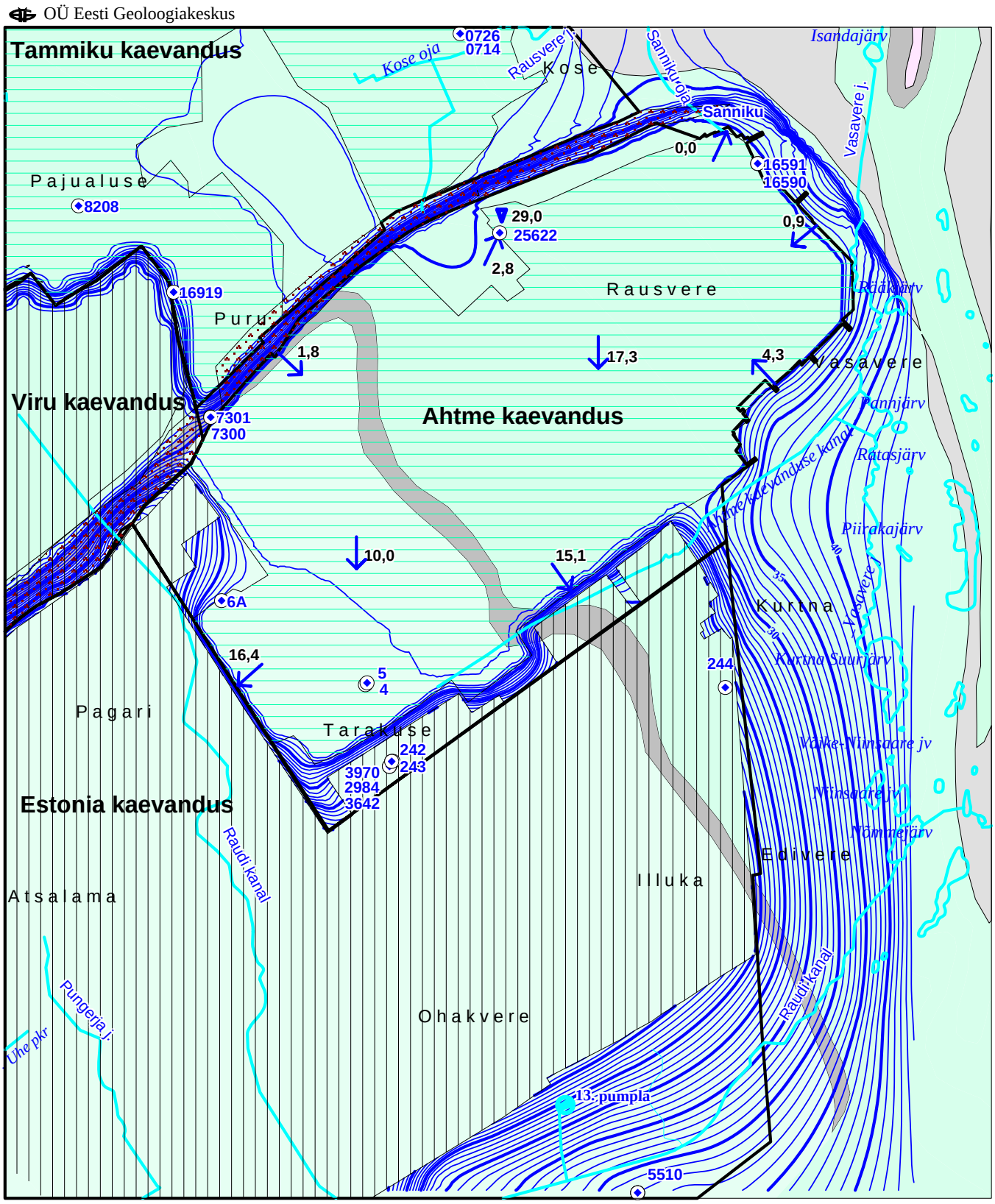
45 - põhjaveetaseme samakõrgusjoon
potentiometric contour

- ammendatud ala
mined out area

3,5 - vooluhulk Q väljavoolul Ahtme kaevandusest, tuhat m³/ööp
discharge of Ahtme mine, t.m³/d

- üleujutatud ala
flooded area

Joonis 4.3.1. Põhjaveetaseme modelleeritud seis 2015. aastal.
Figure 4.3.1. Simulated potentiometric surfase of groundwater in Estonia and Ahtme mine area in 2015.



Joonis 4.3.2. Põhjaveetaseme modelleeritud seis 2030. aastal pärast Estonia kaevanduse ammendamist.
Figure 4.3.2. Simulated potentiometric surfase of groundwater after closing of Estonia mine in 2030.

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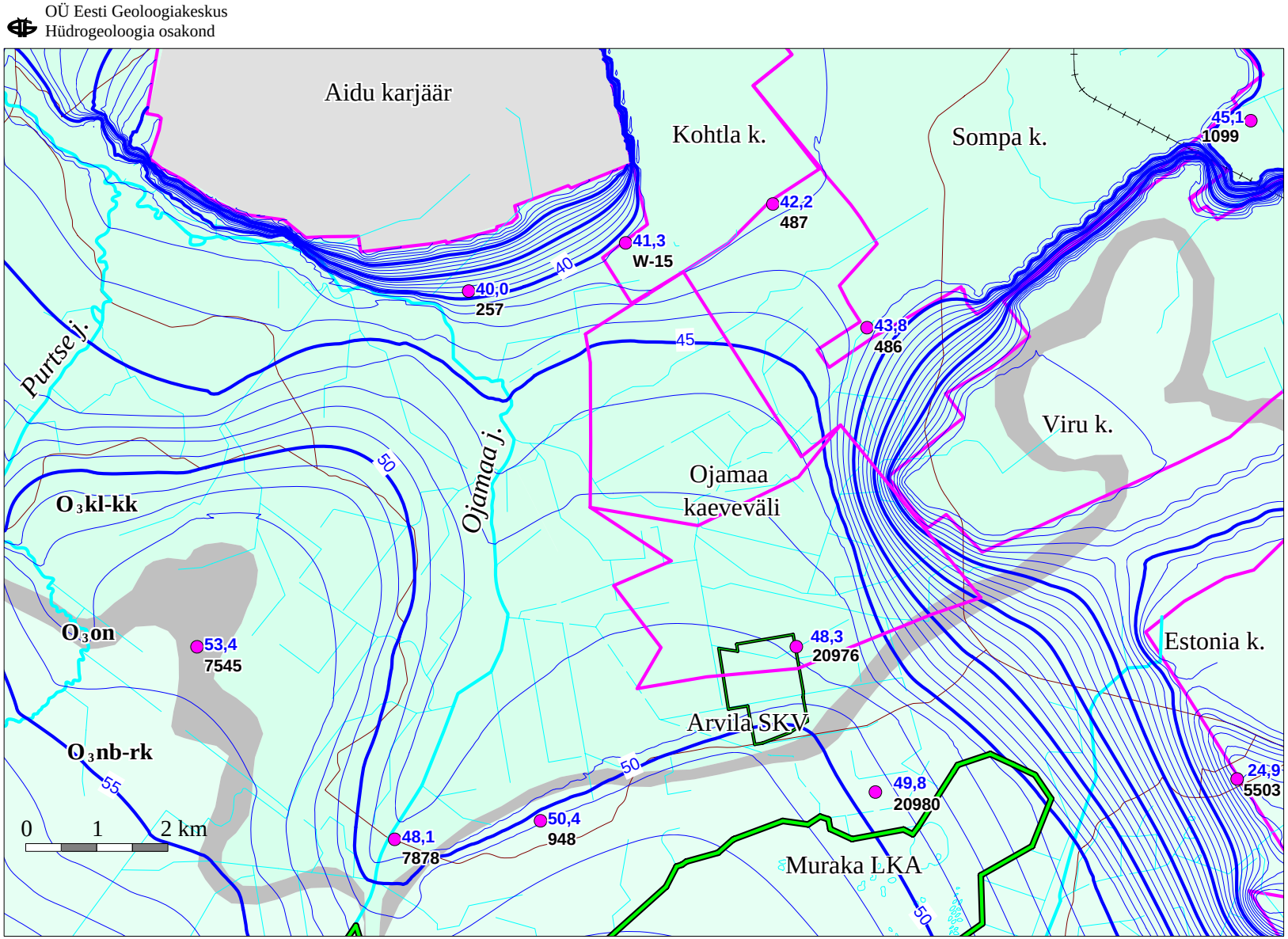

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50,4 948 vaatluskaev: ülal - veetaseme abs.k., m
all - vk. number

põhjaveetaseme samakõrgusjoon

Joonis 4.3.3. Keila-Kukruse veekihi põhjaveetaseme modelleeritud seis Ojamaa kaevevälja piirkonnas 2009. aastal.
Figure 4.3.3. Simulated potentiometric surface of Keila–Kukruse aquifer in Ojamaa mine field area in 2009.

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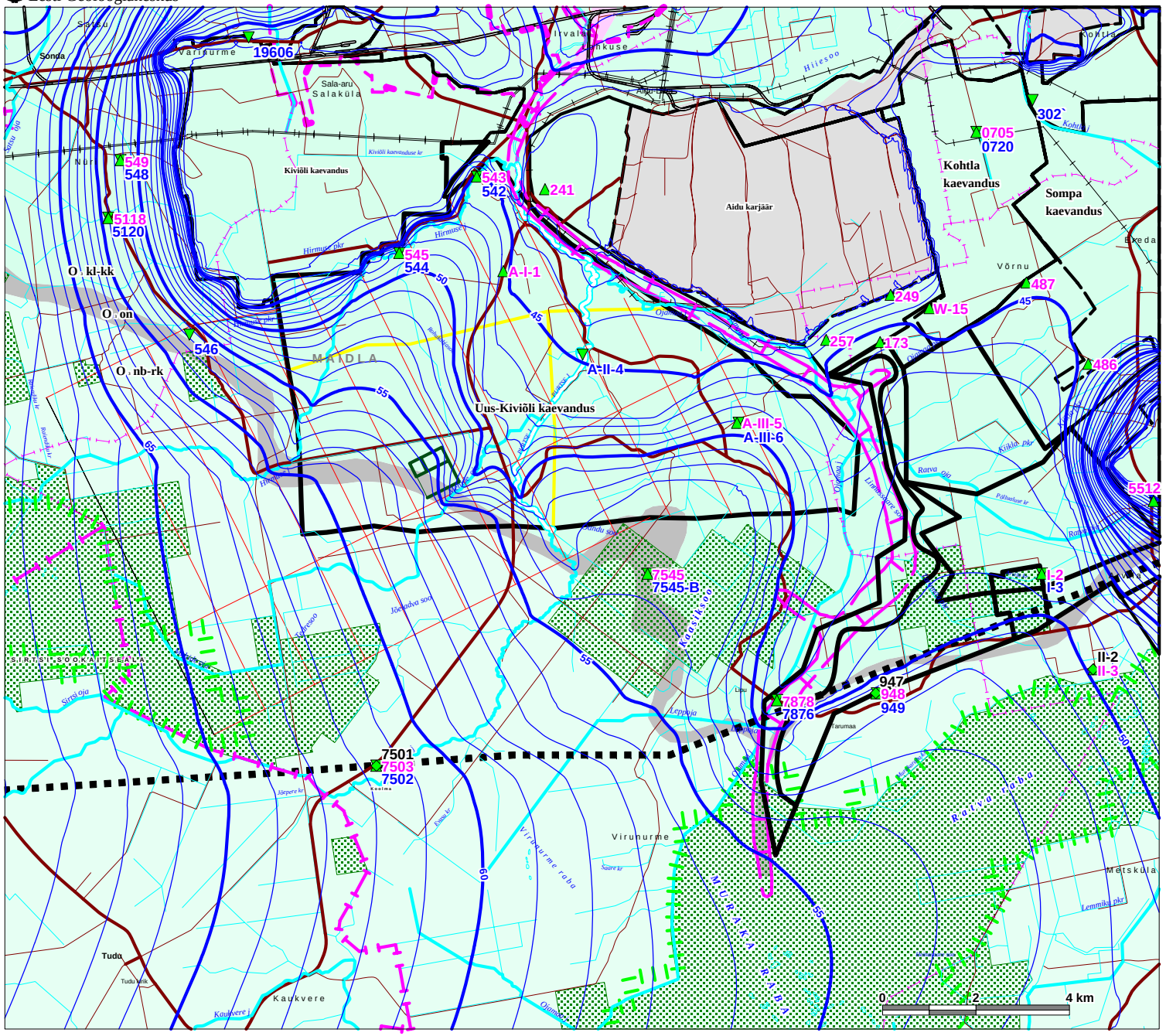

Leppemärgid	Legend
50 Hüdroisohüpsid	Water level
Ahtme rikkevöönd	Ahtme fault
Savala mattunud org	Savala buried valley
Vaatluskaevud:	Monitoring wells:
948 Nabala-Rakvere veekiht	Nabala-Rakvere aquifer
948 Keila-Kukruse veekiht	Keila-Kukruse aquifer
948 Lasnamäe-Kunda veekiht	Lasnamäe-Kunda aquifer
Kaitseala	Kaitseala

Joonis 4.3.4. Hüdroisohüpsid, kui Aidu karjääris on veetase absoluutkõrgusel 42 m. Uus-Kiviõli kaevanduse algseis.
Figure 4.3.4. Simulated initial position of the groundwater level in Uus-Kiviõli mine area after closing of Aidu opencast on water level of 42 m a.s.l.

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First of all were solved the tasks of mining at 1. and 3. year, if groundwater inflow was 32 000 and 63 000 m³ per day correspondingly (Figure 4.3.5). Four tasks were solved depending on approach of Uus-Kiviüli and Ojamaa mining areas to flooded Kiviõli mine (Figure 4.3.6).

Analogical simulations were carried out when the area of mining works reach Savala buried valley (Figure 4.3.7).

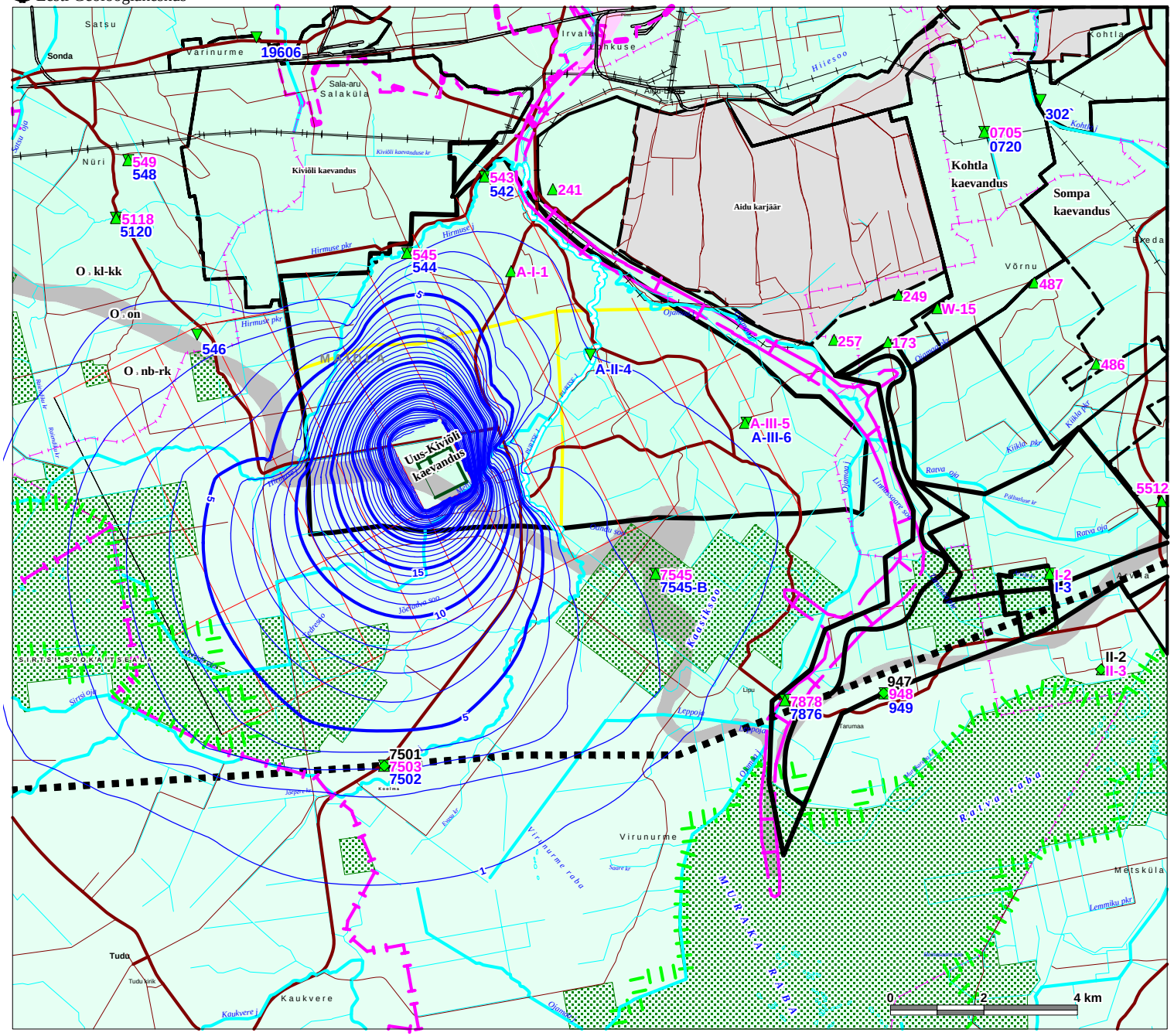
At Hirmuse and Purtse Rivers the areas were found where probably the loss of outflow into the mine will take place.

The average annual inflow into the mine is estimated of 250 000–260 000 m³ per day. The development of groundwater drawdown cones is characterized by cross-section at Figure 4.3.8.

Case study 3

In recent years the Keila–Kukruse aquifer in Viru mine is drained by lowering of groundwater level from 70.0 m a.s.l. up to 14–17 m a.s.l. It is estimated that 40–45% of inflow into Viru mine comes from Sompa and Tammiku mine. The simulated distribution of mine water flow between mines in central part of oil shale deposit after flooding of Viru mine in 2013 is presented in Figure 4.3.9. Besides is presumed that the water level in Viru mine will be arise up to 60 m a.s.l and in Aidu opencast up to 42 m a.s.l.

Eesti Geoloogiakeskus



Leppemärgid	Legend
20 Põhjaveeteaseme alandus	Water lowering
Ahtme rikkevöönd	Ahtme fault
Savala mattunud org	Savala buried valley
Vaatluskaevud:	Monitoring wells:
948 Nabala-Rakvere veekiht	Nabala-Rakvere aquifer
948 Keila-Kukruse veekiht	Keila-Kukruse aquifer
948 Lasnamäe-Kunda veekiht	Lasnamäe-Kunda aquifer
Kaitseala	Kaitseala

Joonis 4.3.5. Veetaseme alanemine esialgsest Uus-Kiviõli kaevanduse 1. tööaasta lõpuks.
Figure 4 3.5.. Simulated drawdown of groundwater level of Uus-Kiviõli mine after first year.

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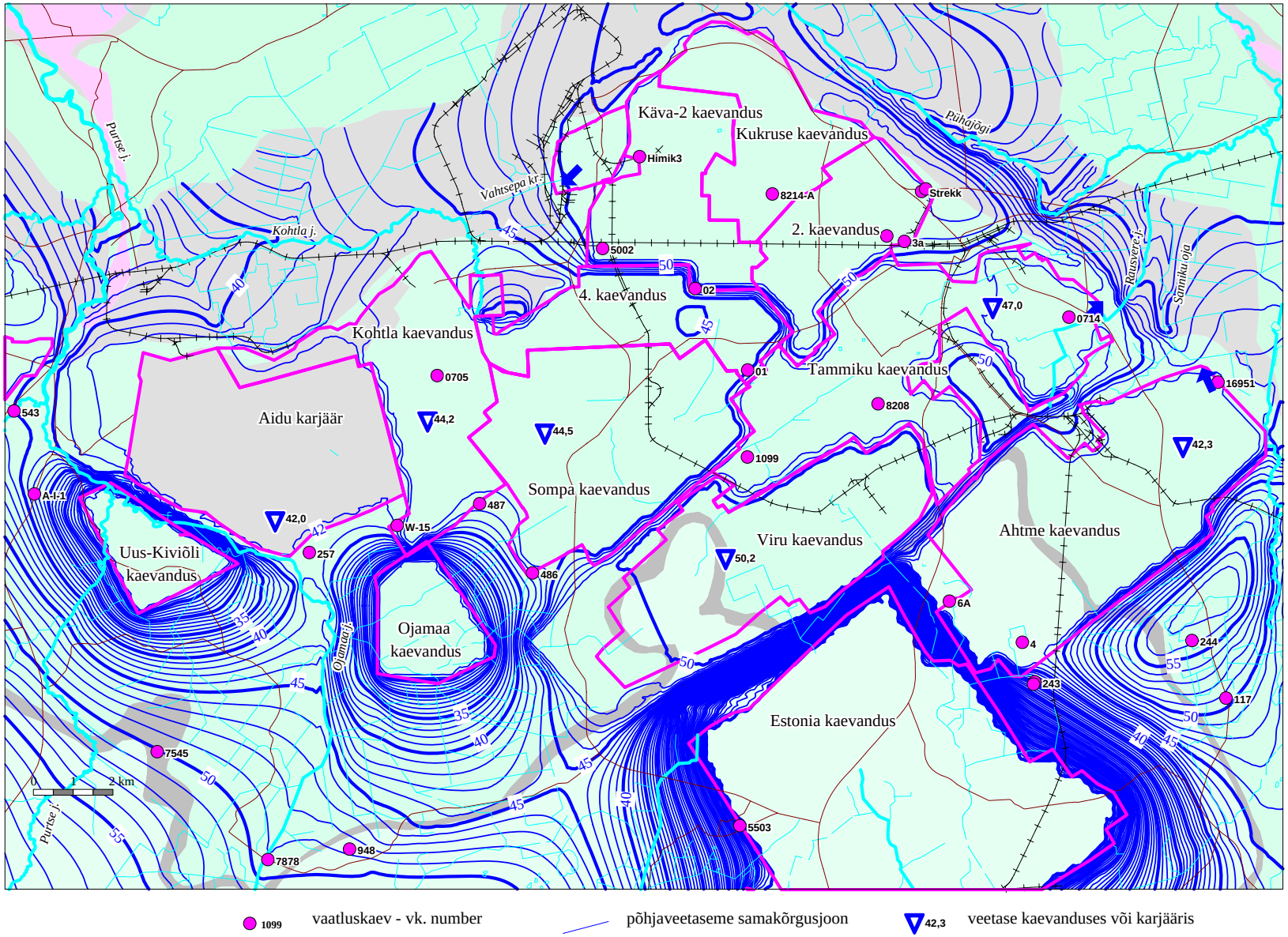

Joonis 4.3.6. Modelleeritud põhjaveetase Uus-Kiviõli ja Ojamaa kaevanduse töötamisel pärast Viru kaevanduse sulgemist ja Aidu karjääri veega täitumist.

Figure 4.3.6. Simulated potentiometric surface of groundwater around Uus-Kiviõli and Ojamaa mines after closing of Viru mine and flooding of Aidu opencast.

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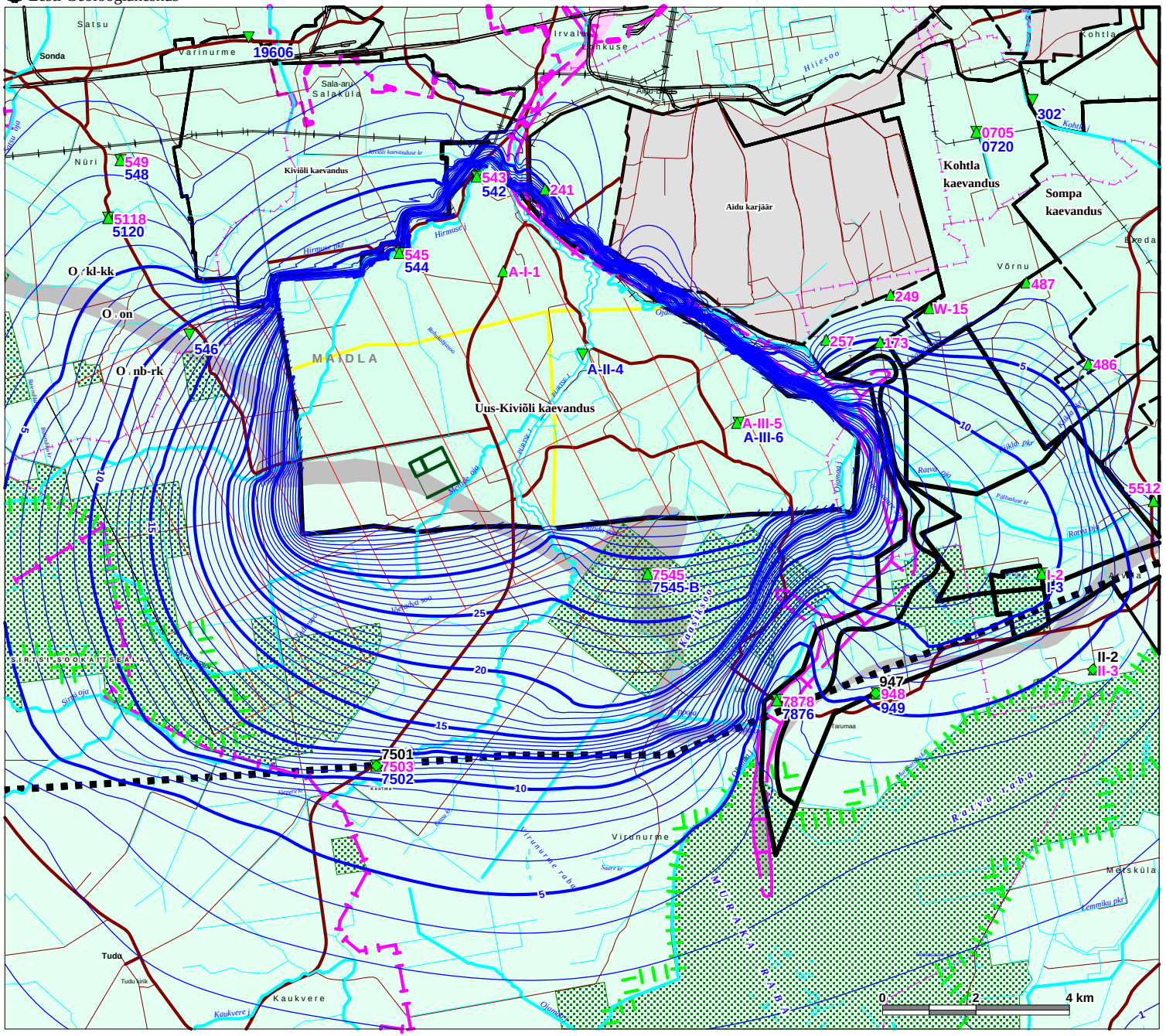

Leppemärgid — Legend

20	Põhjaveetaseme alandus	Water lowering
	Ahtme rikkevöönd	Ahtme fault
	Savala mattunud org	Savala buried valley
	Vaatluskaevud:	Monitoring wells:
948	Nabala-Rakvere veekiht	Nabala-Rakvere aquifer
948	Keila-Kukruse veekiht	Keila-Kukruse aquifer
948	Lasnamäe-Kunda veekiht	Lasnamäe-Kunda aquifer
	Kaitseala	Kaitseala

Joonis 4.3.7. Veetaseme alanemine esialgsest Uus-Kiviõli kaevanduse lähenemisel Savala mattunud orule (kaevandamise lõppfaasis).
Figure 4.3.7. Simulated drawdown of groundwater level from preliminary in Uus-Kiviõli mine area in period coming to an end and reaching to Savala buried valley of mining from Uus-Kiviõli mine.

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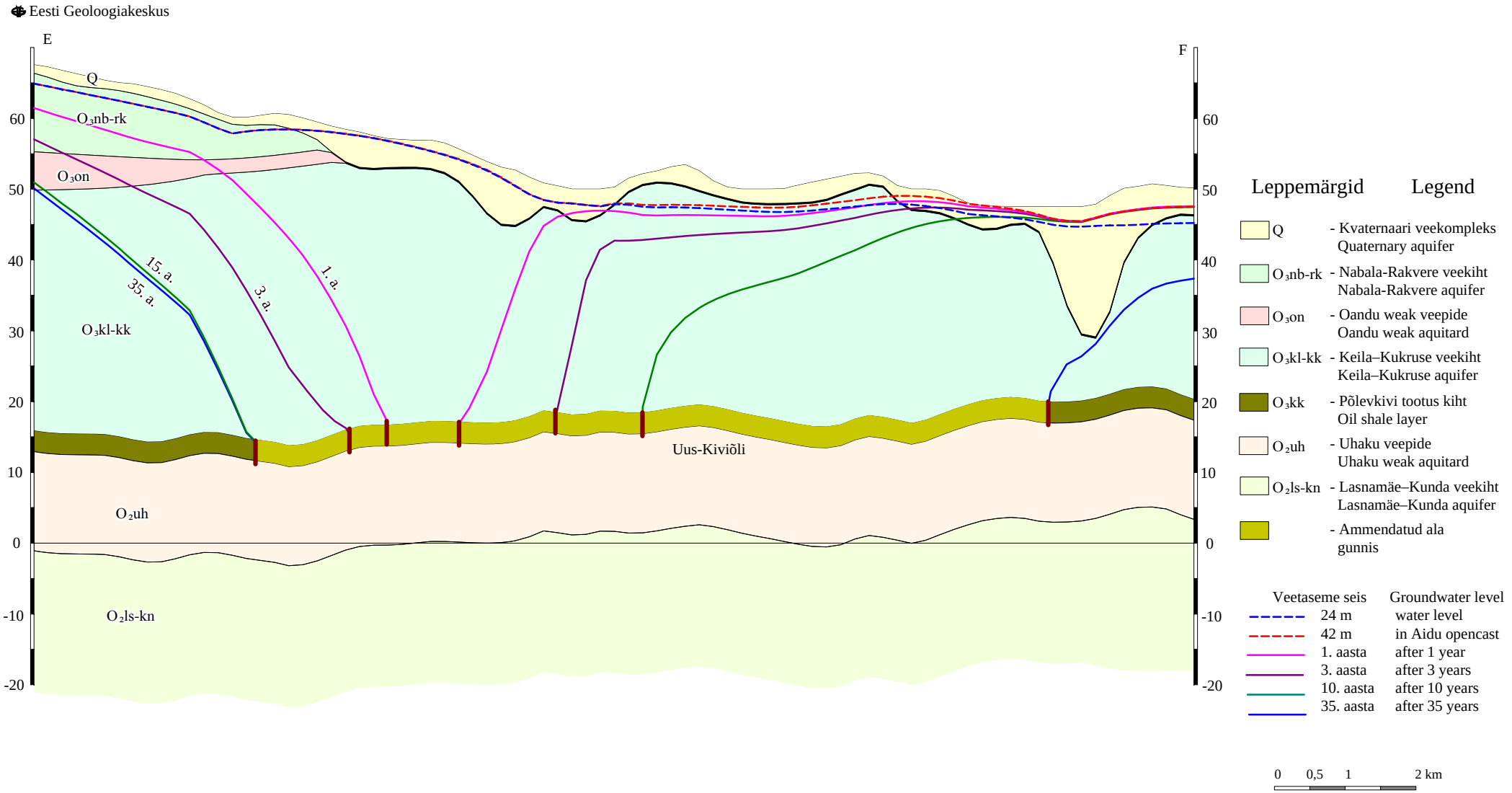

Joonis 4.3.8. Uus-Kiviõli kaevanduse piirkonna veetasemete modelleeritud seis kaevandamise erinevatel perioodidel.
Figure 4.3.8. Simulated groundwater level in Uus-Kiviõli mining area on different period of mining activity.

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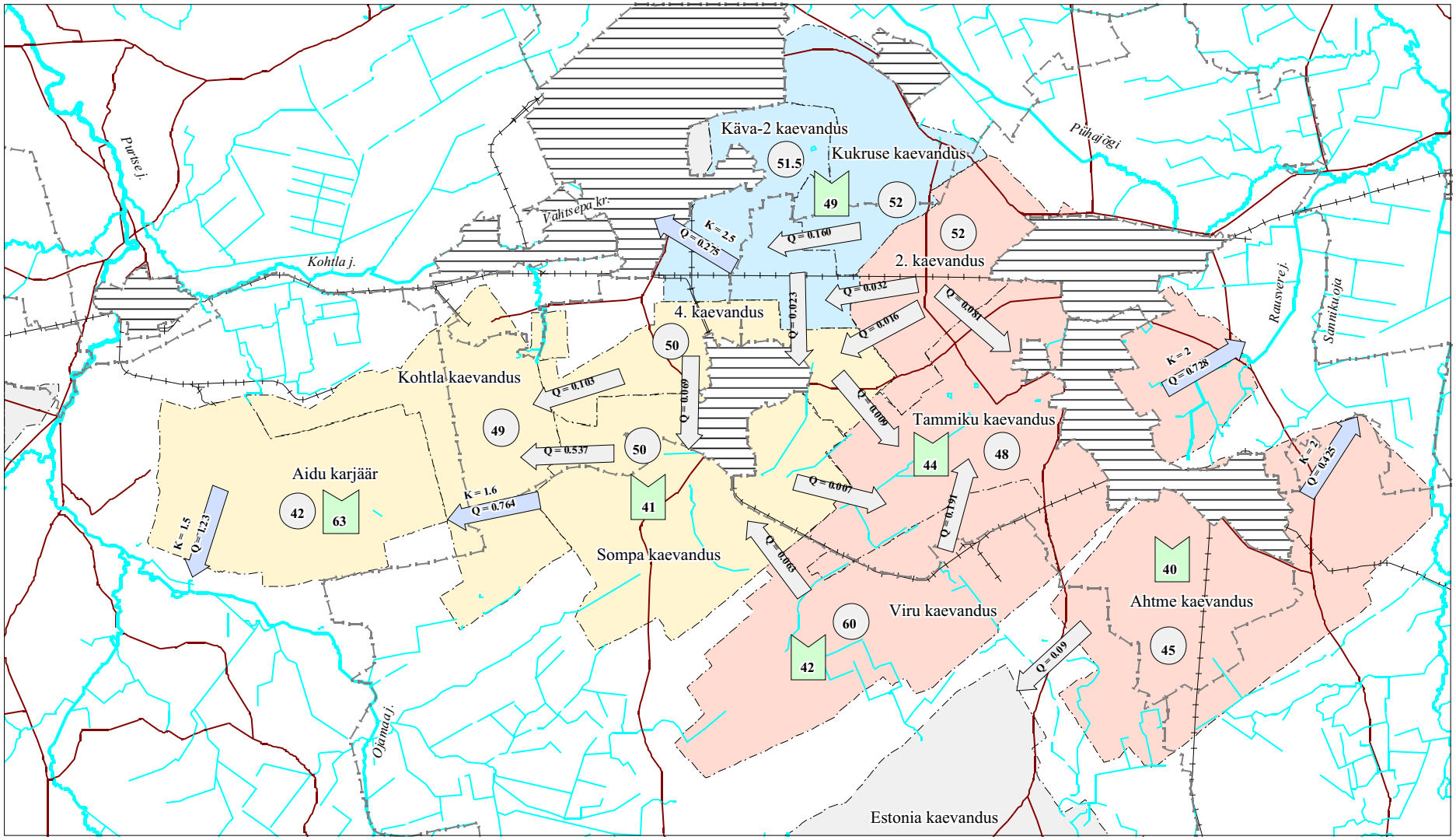

Joonis 4.3.9. Läbivoolu jaotumine kaevanduste vahel ja äravool pinnaveevooluna Aidu karjääri vee abs. kõrgusel 42 m.
Figure 4.3.9. Simulated distribution of mine water flow between mines and discharge from Aidu opencast into surface water after closing of opencast Aidu on groundwater level of 42 m a.s.l.

Appendix 1

Chemical composition of groundwater

Table . The chemical composition of groundwater of Keila–Kukruse aquifer in mining areas of Oil Shale Basin

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	Hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
Kukruse mine																			
8214-A	10.08.83	mg/l	17,0	12,5	0,40	276,6	68,9		0,30	56,7	588,4	8,90	0,015		433,2	7,3	18,8	1470,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,74	0,32	0,02	13,80	5,66		0,013	1,60	12,24	0,14			7,10	19,5	1,0	1270,0	
8214-A	30.05.85	mg/l	17,5	10,0	<0,05	267,1	57,7			52,4	474,0	11,50	<0,003		500,3	6,9	52,8	1395,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,76	0,26		13,33	4,74			1,48	9,86	0,19			8,20	18,1	2,4	1215,0	
8214-A	07.07.85	mg/l	20,0	13,3	<0,05	287,4	62,0	0,14	0,38	57,8	642,4	<0,40	<0,003		353,9	7,7	13,2	1440,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,34		14,34	5,10	0,005	0,017	1,63	13,36				5,80	19,4	1,9	1270,5	
8214-A	08.04.86	mg/l	15,8	14,5	<0,05	285,4	63,4		0,10	54,2	554,7	6,60	0,030		500,3	6,5	52,8	1500,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,69	0,37		14,24	5,21		0,004	1,53	11,54	0,11	0,001		8,20	19,4	1,3	1360,5	
8214-A	16.07.86	mg/l	12,8	13,0	<0,05	289,2	65,5	0,74	0,92	59,6	489,5	6,70	0,024		494,2	7,5	44,0	1442,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,56	0,33		14,43	5,38	0,026	0,041	1,68	10,18	0,11	0,001		8,10	19,8	1,3	1270,0	
8214-A	05.06.87	mg/l	10,6	6,0	<0,05	209,2	41,2			32,6	332,5	5,00	<0,003	6,0	396,6	7,6	8,8	1050,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,46	0,15		10,44	3,39			0,92	6,92	0,08		0,20	6,50	13,8	2,6	990,0	
8214-A	21.07.87	mg/l	17,2	10,7	<0,05	269,5	62,0			52,1	513,3	13,80	<0,003		488,1	7,2	26,6	1431,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,75	0,27		13,45	5,10			1,47	10,68	0,22			8,00	18,6	1,5	1272,0	
8214-A	08.06.88	mg/l	17,8	9,7	0,20	264,1	61,4		0,08	55,0	480,0	8,10	<0,003		475,9	7,5	19,8	1380,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,77	0,25	0,01	13,18	5,05		0,004	1,55	9,98	0,13			7,80	18,2	2,4	1225,0	
8214-A	12.07.88	mg/l	19,3	10,0	0,10	211,4	63,8	0,11	0,29	51,8	460,0	4,10	<0,003		366,1	7,7	13,2	1190,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,84	0,26	0,01	10,55	5,24	0,004	0,013	1,46	9,57	0,07			6,00	15,8	2,1	1098,0	
8214-A	24.08.88	mg/l	100,0	11,0	<0,05	162,3	50,6	0,07	0,20	188,3	345,0	9,10	<0,003		280,7	7,7	22,0	1150,0	SO4-Cl-HCO3-Ca-Na-Mg
		mg-ekv/l	4,35	0,28		8,10	4,16	0,003	0,009	5,31	7,18	0,15			4,60	12,3	1,8	1064,0	
8214-A	16.05.89	mg/l	20,0	10,0	<0,05	272,5	57,1			55,3	474,9	17,90	0,026		506,4	7,3		1421,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,26		13,60	4,69			1,56	9,88	0,29	0,001		8,30	18,3	0,8	1302,0	
8214-A	12.07.89	mg/l	19,3	9,2	<0,05	242,5	67,3	1,11	1,44	56,7	458,4	11,40	0,022		451,5	7,5	22,0	1323,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,84	0,24		12,10	5,53	0,040	0,065	1,60	9,53	0,18			7,40	17,6	1,9	1056,0	
8214-A	27.04.95	mg/l	3,5	1,8	<0,03	167,7	19,2		0,05	9,2	176,1	0,10	0,015	12,0	372,2	7,3	19,8	770,0	HCO3-SO4-Ca
		mg-ekv/l	0,15	0,05		8,37	1,58		0,002	0,26	3,66			0,40	6,10	9,9	5,8	608,5	
8214-A	20.06.01	mg/l	4,0	1,9	0,01	105,0	15,6	0,17	0,92	4,7	150,0	0,89	0,007			7,3			-
		mg-ekv/l	0,17	0,05		5,24	1,28	0,006	0,041	0,13	3,12	0,01				6,5		620,0	
Sompa mine																			
116-P	19.04.63	mg/l	10,4		<0,05	100,2	33,4			8,7	156,0	11,70	0,050		262,2	7,5		583,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,45			5,00	2,75			0,25	3,24	0,19	0,001		4,30	7,8		452,8	
116-P	25.11.63	mg/l	49,2		0,10	147,3	47,1		0,30	56,0	337,8	15,10	0,010		249,8	7,5		900,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	2,14		0,01	7,35	3,87		0,013	1,58	7,03	0,24			4,10	11,2	1,5	778,8	
116-P	03.09.64	mg/l	64,6		0,10	117,2	42,0		0,30	107,8	210,3	5,70	0,010		268,3	7,3		820,0	SO4-HCO3-Cl-Ca-Mg-Na+K
		mg-ekv/l	2,81		0,01	5,85	3,45		0,013	3,04	4,37	0,09			4,40	9,3	3,5	686,0	
116-P	04.05.65	mg/l	128,1		0,10	150,3	22,0			48,2	425,1	6,50	0,300		244,8	7,4		1025,0	SO4-HCO3-Ca-Na+K
		mg-ekv/l	5,57		0,01	7,50	1,81			1,36	8,84	0,10	0,007		4,01	9,3	2,7	964,5	
116-P	18.05.72	mg/l	75,5		0,10	143,1	56,7		0,30	96,8	415,6	6,00	0,010		201,1	8,1		1000,0	SO4-HCO3-Ca-Mg-Na+K
		mg-ekv/l	3,28		0,01	7,14	4,66		0,013	2,73	8,64	0,10			3,30	11,8	1,4	932,0	
116-P	16.04.74	mg/l	41,8		<0,05	177,7	60,6			51,1	470,4	14,00	0,010		243,9	7,9		1060,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,82			8,87	4,98			1,44	9,78	0,23			4,00	13,9	1,5	984,0	
116-P	06.09.74	mg/l	70,0		0,10	168,1	60,2			92,9	444,4	8,01	<0,003		237,8	8,0		1082,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	3,04		0,01	8,39	4,95			2,62	9,24	0,13			3,90	13,3	1,8	970,5	
116-P	08.04.75	mg/l	59,3		0,10	369,7	105,9		0,30	42,9	1183,9	5,00	1,100		219,5	7,5		1990,0	SO4-Ca-Mg
		mg-ekv/l	2,58		0,01	18,45	8,70		0,013	1,21	24,63	0,08	0,024		3,60	27,1	1,5	1962,0	
116-P	21.08.75	mg/l	76,0		0,10	162,3	57,2		0,50	123,0	414,0	6,00	<0,003		243,9	8,0		1080,0	SO4-HCO3-Cl-Ca-Mg-Na+K
		mg-ekv/l	3,31		0,01	8,10	4,70		0,022	3,47	8,61	0,10			4,00	12,8	2,7	993,0	
116-P		mg/l	32,2		0,10	161,9	50,3		0,30	28,4	412,7	14,00	0,010		219,3	8,1		920,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	Hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
	13.04.76	mg-ekv/l	1,40		0,01	8,08	4,13		0,013	0,80	8,58	0,23			3,60	12,2	2,7	870,5	SO4-HCO3-Ca-Mg
116-P	24.08.76	mg/l	96,4	16,0	0,10	137,7	50,3		0,30	138,3	386,0	1,00	0,010		207,3	8,1		1030,0	SO4-Cl-HCO3-Ca-Na-Mg
		mg-ekv/l	4,19	0,41	0,01	6,87	4,13		0,013	3,90	8,03	0,02			3,40	11,0	4,3	994,5	
116-P	06.05.77	mg/l	1,5	6,3	0,20	149,9	52,7			33,7	431,7	11,00	0,010		146,3	7,9		833,0	SO4-Ca-Mg
		mg-ekv/l	0,07	0,16	0,01	7,48	4,33			0,95	8,98	0,18			2,40	11,8	3,1	608,5	
116-P	11.04.78	mg/l	22,3	7,3	0,10	156,3	55,9			44,3	455,1	9,00	0,010		158,5	7,9		909,0	SO4-Ca-Mg
		mg-ekv/l	0,97	0,19	0,01	7,80	4,59			1,25	9,47	0,14			2,60	12,4	2,1	860,5	
116-P	16.04.79	mg/l	20,0	6,3	0,10	161,1	50,1			34,4	404,9	14,00	<0,003		231,9	7,9		923,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,16	0,01	8,04	4,12			0,97	8,42	0,23			3,80	12,2	2,8	830,0	
116-P	15.08.79	mg/l	96,5	9,0	0,10	147,1	39,6		0,30	111,3	389,7	2,00	0,010		244,1	7,9		1040,0	SO4-HCO3-Cl-Ca-Na-Mg
		mg-ekv/l	4,20	0,23	0,01	7,34	3,26		0,013	3,14	8,11	0,03			4,00	10,6	2,2	974,0	
116-P	13.04.80	mg/l	18,9	6,3	0,10	153,5	54,7		0,30	51,6	393,8	11,00	0,010		219,7	7,5		910,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,82	0,16	0,01	7,66	4,50		0,013	1,46	8,19	0,18			3,60	12,2	1,6	868,0	
116-P	20.11.80	mg/l	30,0	8,0	0,60	162,1	63,3			27,7	471,6	15,00	0,070		262,4	7,6		1041,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,30	0,20	0,03	8,09	5,20			0,78	9,81	0,24	0,002		4,30	13,3	2,3	1011,5	
116-P	12.04.81	mg/l	22,1	10,0	0,40	180,2	70,0			55,0	500,5	15,10	<0,003		244,1	8,2		1097,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,96	0,26	0,02	8,99	5,75			1,55	10,41	0,24			4,00	14,7	4,2	997,0	
116-P	20.08.81	mg/l	48,4	9,4	0,15	143,3	52,3			73,7	388,5	16,00	0,010		237,8	7,9		970,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	2,11	0,24	0,01	7,15	4,30			2,08	8,08	0,26			3,90	11,4	2,2	928,5	
116-P	30.03.82	mg/l	32,2	9,4	0,20	172,3	59,3			47,9	440,3	35,20	0,010	6,0	238,0	7,9	2,2	1046,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,40	0,24	0,01	8,60	4,87			1,35	9,16	0,57		0,20	3,90	13,5	5,5	995,0	
116-P	25.05.83	mg/l	43,1	7,0	0,20	125,9	51,3		0,30	69,8	351,4	2,00	0,010		207,5	7,8	6,6	870,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,87	0,18	0,01	6,28	4,22		0,013	1,97	7,31	0,03			3,40	10,5	1,9	828,5	
116-P	22.08.83	mg/l	37,0	10,0	0,15	157,9	73,9			75,5	482,7	<0,40	0,010		256,3	7,8	8,8	1097,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,61	0,26	0,01	7,88	6,07			2,13	10,04				4,20	13,9	1,2	1037,0	
116-P	16.04.84	mg/l	15,0	9,5	0,15	210,4	76,8		0,40	31,2	597,9	21,60	0,010		305,1	7,7	2,2	1270,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,65	0,24	0,01	10,50	6,31		0,018	0,88	12,44	0,35			5,00	16,8	1,2	1228,0	
116-P	13.09.84	mg/l	26,3	8,7	0,15	177,6	72,6			53,9	479,8	4,00	<0,003	18,0	280,7	7,0	2,2	1126,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,14	0,22	0,01	8,86	5,97			1,52	9,98	0,06		0,60	4,60	14,8	2,7	1014,5	
116-P	20.04.85	mg/l	18,0	6,0	<0,05	162,1	53,8			33,0	7,0	391,30	15,900	6,0	256,3	7,7	6,6	962,0	NO3-HCO3-Ca-Mg
		mg-ekv/l	0,78	0,15		8,09	4,42			0,93	0,15	6,30	0,345	0,20	4,20	12,5	1,9	880,0	
116-P	24.07.85	mg/l	25,6	11,7	0,10	183,2	73,0	0,10	0,10	50,3	539,9	1,80	<0,003		280,7	7,9	13,2	1170,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,11	0,30	0,01	9,14	6,00	0,004	0,004	1,42	11,23	0,03			4,60	15,1	2,8	1158,0	
116-P	22.05.86	mg/l	20,5	8,5	<0,05	187,4	71,7			44,7	500,8	2,60	<0,003		305,1	7,8	15,4	1146,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,89	0,22		9,35	5,89			1,26	10,42	0,04			5,00	15,2	4,9	1013,5	
116-P	02.09.86	mg/l	21,4	9,3	<0,05	205,4	54,4	0,06	0,07	44,3	493,0	4,30	0,138	6,0	292,9	7,6	15,4	1140,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,93	0,24		10,25	4,47	0,002	0,003	1,25	10,25	0,07	0,003	0,20	4,80	14,7	2,7	1060,0	
116-P	04.06.87	mg/l	15,0	9,2	<0,05	182,4	70,5		0,01	32,6	469,5	7,80	<0,003		317,3	7,9	2,2	1110,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,65	0,24		9,10	5,80			0,92	9,77	0,13			5,20	14,9	3,5	1004,0	
116-P	06.08.87	mg/l	20,0	9,3	<0,05	169,7	66,7	0,08	0,11	37,9	452,6	3,40	0,018	6,0	299,0	7,9	4,4	1070,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,24		8,47	5,48	0,003	0,005	1,07	9,41	0,05		0,20	4,90	13,9	2,8	955,5	
116-P	08.06.88	mg/l	23,5	9,4	0,40	165,1	65,1		0,10	47,5	389,3	4,30	<0,003	18,0	268,5	8,3		1000,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,02	0,24	0,02	8,24	5,35		0,004	1,34	8,10	0,07		0,60	4,40	13,6	2,9	928,5	
116-P	14.07.88	mg/l	21,4	8,0	<0,05	158,3	67,5			46,5	438,0	1,50	<0,003	6,0	268,5	7,8	8,8	1020,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,93	0,20		7,90	5,55			1,31	9,11	0,02		0,20	4,40	13,4	2,9	970,5	
116-P	17.05.89	mg/l	27,5	8,8	<0,05	139,3	60,8		0,02	55,3	400,8	2,20	0,008	6,0	244,1	8,0	4,4	950,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,20	0,23		6,95	5,00		0,001	1,56	8,34	0,04		0,20	4,00	11,9	3,2	891,5	
116-P	12.07.89	mg/l	30,6	9,5	<0,05	158,7	66,6	0,09	0,12	63,5	411,5	2,40	<0,003	6,0	292,8	7,9		1050,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,33	0,24		7,92	5,47	0,003	0,005	1,79	8,56	0,04		0,20	4,80	13,4	2,1	971,5	
116-P	03.04.90	mg/l	19,3	8,0	<0,05	165,5	58,0			38,6	382,7	12,80	0,015	18,0	274,6	8,0	4,4	983,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,84	0,20		8,26	4,77			1,09	7,96	0,21		0,60	4,50	13,0	2,3	884,5	
116-P	17.09.90	mg/l	27,9	9,0	<0,05	166,7	65,8	0,10	0,13	64,5	409,0	3,20	0,028	24,0	256,3	8,0	22,0	1030,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,21	0,23		8,32	5,41	0,004	0,006	1,82	8,51	0,05	0,001	0,80	4,20	13,7	2,9	941,0	
116-P	06.06.91	mg/l	26,3	8,5	<0,05	161,3	62,6			58,1	373,2	3,50	<0,003	12,0	268,5	8,0		980,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,14	0,22		8,05	5,15			1,64	7,76	0,06		0,40	4,40	13,2	2,8	980,1	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	Hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
116-P	09.10.91	mg/l	23,7	9,3	<0,05	169,3	61,4		0,12	52,8	395,0	6,20	0,020	6,0	299,0	8,1		1030,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,03	0,24		8,45	5,05		0,005	1,49	8,22	0,10		0,20	4,90	13,5	2,7	1102,5	
116-P	31.01.93	mg/l	69,0		0,21	158,3	57,2		0,03	48,0	427,0	4,87	0,005		323,2			1087,7	SO4-HCO3-Ca-Mg
		mg-ekv/l	3,00		0,01	7,90	4,70		0,001	1,35	8,88	0,08			5,30	12,6		992,0	
116-P	19.05.94	mg/l	16,5	10,0	<0,03	175,4	12,2		0,12	39,0	202,0	2,40	0,007		323,0	8,7		780,0	HCO3-SO4-Ca
		mg-ekv/l	0,72	0,26		8,75	1,00		0,005	1,10	4,20	0,04			5,30	9,8	4,0	742,0	
116-P	23.08.94	mg/l	126,5	8,0	<0,03	70,0	85,0		0,10	70,0	477,0	0,29	0,008	0,0	275,0	8,3	0,0	1110,0	SO4-HCO3-Mg-Na-Ca
		mg-ekv/l	5,50	0,20		3,49	6,99		0,004	1,97	9,92				4,51	10,5	1,5	1103,0	
Kohtla mine																			
117-P	03.09.64	mg/l	32,7		<0,05	228,5	41,3		0,30	71,3	456,8	0,70	0,010		274,4	7,4		1110,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,42			11,40	3,39		0,013	2,01	9,50	0,01			4,50	14,8	3,2	958,5	
117-P	17.03.65	mg/l	42,8		0,10	240,9	36,8			69,1	483,1	<0,40	<0,003		399,0	7,4		1270,0	SO4-HCO3-Ca
		mg-ekv/l	1,86		0,01	12,02	3,02			1,95	10,05				6,54	15,0	2,4	1118,5	
117-P	20.04.73	mg/l	164,4		0,10	45,5	17,9			269,1	10,0	55,00	0,010		128,0	7,4		690,0	Cl-Na+K-Ca
		mg-ekv/l	7,15		0,01	2,27	1,47			7,59	0,21	0,89			2,10	3,7	3,0		
117-P	16.04.74	mg/l	34,3		<0,05	292,6	53,9			41,8	684,7	6,00	0,010		305,1	7,8		1418,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,49			14,60	4,43			1,18	14,24	0,10			5,00	19,0	3,2	1302,3	
117-P	03.09.74	mg/l	36,3		<0,05	260,1	53,9			59,9	603,7	2,00	<0,003		274,0	7,8		1290,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,58			12,98	4,43			1,69	12,56	0,03			4,49	17,4	3,0	1181,5	
117-P	05.05.75	mg/l	15,2		<0,05	306,4	57,1			42,9	729,2	4,00	0,010		250,1	7,5		1405,0	SO4-Ca-Mg
		mg-ekv/l	0,66			15,29	4,69			1,21	15,17	0,06			4,10	20,0	2,4	1407,5	
117-P	21.08.75	mg/l	24,2		0,10	234,5	49,8		0,40	53,5	540,7	<0,40	<0,003		268,3	7,9		1170,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,05		0,01	11,70	4,09		0,018	1,51	11,25				4,40	15,8	4,5	1090,0	
117-P	14.04.76	mg/l	36,6		0,10	280,0	52,2		0,30	26,6	689,7	<0,40	0,300		255,9	7,9		1340,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,59		0,01	13,97	4,29		0,013	0,75	14,35		0,007		4,20	18,3	3,5	1310,5	
117-P	06.05.77	mg/l	11,2	6,4	0,10	268,1	52,1			28,4	748,1	7,00	0,150		140,2	7,5		1262,0	SO4-Ca-Mg
		mg-ekv/l	0,49	0,16	0,01	13,38	4,28			0,80	15,56	0,11	0,003		2,30	17,7	3,0	1255,0	
117-P	11.04.78	mg/l	14,2	7,7	0,10	262,5	60,8			42,5	672,4	7,00	0,150		225,7	7,6		1293,0	SO4-Ca-Mg
		mg-ekv/l	0,62	0,20	0,01	13,10	5,00			1,20	13,99	0,11	0,003		3,70	18,1	1,9	1219,0	
117-P	28.04.80	mg/l	47,6		0,10	225,5	54,7			35,8	607,8	3,00	0,015		213,6	7,9		1188,0	SO4-Ca-Mg
		mg-ekv/l	2,07		0,01	11,25	4,50			1,01	12,64	0,05			3,50	15,8	3,1	1176,0	
117-P	20.11.80	mg/l	160,0	12,0	30,00	55,9	20,3	0,80	1,10	250,7	49,4	6,00	<0,003		183,1	7,1		770,0	Cl-HCO3-Na-Ca
		mg-ekv/l	6,96	0,31	1,66	2,79	1,67	0,029	0,049	7,07	1,03	0,10			3,00	4,5	4,8	700,5	
117-P	12.04.81	mg/l	11,0	6,5	0,10	212,8	58,9			39,0	555,5	7,30	0,010		236,9	7,9		1128,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,48	0,17	0,01	10,62	4,84			1,10	11,55	0,12			3,89	15,5	2,5	1241,5	
117-P	20.08.81	mg/l	17,4	8,2	0,15	204,2	52,9			44,0	556,8	7,00	0,010		183,0	7,9		1074,0	SO4-Ca-Mg
		mg-ekv/l	0,76	0,21	0,01	10,19	4,35			1,24	11,58	0,11			3,00	14,5	3,1	1144,5	
117-P	03.03.82	mg/l	12,7	5,7	0,10	247,7	54,0			33,7	609,4	14,90	0,010	6,0	201,4	7,6	4,4	1190,0	SO4-Ca-Mg
		mg-ekv/l	0,55	0,15	0,01	12,36	4,44			0,95	12,68	0,24		0,20	3,30	16,8	2,5	1215,5	
117-P	14.09.82	mg/l	18,5	7,3	0,15	224,5	55,3			54,2	524,3	<0,40	0,010		292,9	7,7	4,4	1184,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,80	0,19	0,01	11,20	4,55			1,53	10,91				4,80	15,8	4,2	1129,0	
117-P	22.08.83	mg/l	19,3	6,0	0,30	224,1	60,0			52,1	539,1	2,20	<0,003		299,0	7,6	11,0	1207,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,84	0,15	0,02	11,18	4,93			1,47	11,21	0,04			4,90	16,1	1,1		
117-P	16.04.84	mg/l	10,0	6,0	0,10	267,5	57,1		0,40	25,9	632,5	13,10	0,010	6,0	311,2	7,6	4,4	1330,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,43	0,15	0,01	13,35	4,69		0,018	0,73	13,16	0,21		0,20	5,10	18,0	3,4	1257,5	
117-P	21.08.84	mg/l	21,7	6,0	0,10	224,9	59,3		0,30	52,1	537,8	4,00	<0,003		305,1	7,4	2,2	1230,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,94	0,15	0,01	11,22	4,87		0,013	1,47	11,19	0,06			5,00	16,1	1,6	1168,5	
117-P	20.04.85	mg/l	18,0	4,8	<0,05	256,9	50,1			44,7	553,9	6,20	<0,003	6,0	329,5	7,6	13,2	1291,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,78	0,12		12,82	4,12			1,26	11,52	0,10		0,20	5,40	16,9	1,8	1156,0	
117-P	08.08.85	mg/l	18,3	6,7	<0,05	256,1	50,5	0,12	0,12	37,2	599,6	4,90	<0,003		305,1	7,7	8,8	1280,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,80	0,17		12,78	4,15	0,004	0,005	1,05	12,47	0,08			5,00	16,9	2,5	1253,0	
117-P	22.05.86	mg/l	21,0	4,9	<0,05	238,3	43,3			54,2	518,9	<0,40	0,016		280,7	7,7	24,2	1167,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,91	0,13		11,89	3,56			1,53	10,79				4,60	15,4	3,4	1055,0	
117-P	03.09.86	mg/l	21,4	5,0	<0,05	225,1	64,9	0,12	0,12	40,8	609,4	3,10	0,018		268,5	7,7	13,2	1240,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,93	0,13		11,23	5,33	0,004	0,005	1,15	12,68	0,05			4,40	16,6	2,7	1179,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	Hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
117-P	05.06.87	mg/l	21,4	6,4	1,50	251,9	53,1			43,6	521,8	9,00	<0,003		353,9	7,7	6,6	1268,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,93	0,16	0,08	12,57	4,36			1,23	10,85	0,14			5,80	16,9	1,9	1277,0	
117-P	06.08.87	mg/l	20,0	6,8	<0,05	249,9	54,2	0,16	0,16	48,6	530,0	7,00	0,034		353,9	7,5	15,4	1270,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,17		12,47	4,46	0,006	0,007	1,37	11,02	0,11	0,001		5,80	16,9	2,3	1156,0	
117-P	03.03.88	mg/l	20,0	6,0	<0,05	196,4	35,7			43,3	471,6	0,40	0,010		219,7	7,7	4,4	997,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,15		9,80	2,93			1,22	9,81	0,01			3,60	12,7	2,2	923,5	
117-P	24.08.88	mg/l	20,0	5,3	<0,05	346,9	45,0	0,17	0,17	52,1	568,7	1,90	0,072		268,5	7,5	20,8	1310,0	SO4-HCO3-Ca
		mg-ekv/l	0,87	0,14		17,31	3,70	0,006	0,008	1,47	11,83	0,03	0,002		4,40	21,0	2,9	1253,5	
117-P	17.05.89	mg/l	18,9	6,8	<0,05	213,7	49,8		0,01	43,6	463,3	6,20	0,010		323,4	7,7	13,2	1130,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,82	0,17		10,66	4,09			1,23	9,64	0,10			5,30	14,8	2,5	1060,0	
117-P	10.08.89	mg/l	18,8	6,0	<0,05	265,7	58,2	1,05	1,05	40,1	694,6	<0,40	0,040	6,0	238,0	7,4	4,4	1330,0	SO4-Ca-Mg
		mg-ekv/l	0,82	0,15		13,26	4,78	0,038	0,047	1,13	14,45		0,001	0,20	3,90	18,0	2,9	1385,5	
117-P	03.04.90	mg/l	17,9	5,5	<0,05	207,6	46,1			35,1	481,0	8,40	0,012		280,7	7,9	4,4	1087,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,78	0,14		10,36	3,79			0,99	10,00	0,14			4,60	14,2	1,2	1015,5	
117-P	24.07.90	mg/l	20,0	7,5	<0,05	231,5	50,8			47,5	493,8	5,30	<0,003		347,8	7,9	2,2	1211,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,19		11,55	4,18			1,34	10,27	0,09			5,70	15,7	10,9	1258,5	
117-P	06.06.91	mg/l	21,3	5,2	<0,05	194,6	40,1		0,03	47,2	430,8	1,80	<0,003		268,5	7,6	15,4	1020,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,93	0,13		9,71	3,30		0,001	1,33	8,96	0,03			4,40	13,0	1,9	972,5	
117-P	08.10.91	mg/l	19,0	4,8	0,60	218,0	41,3	0,29	0,35	45,7	455,9	5,50	<0,003		305,1	8,2	11,0	1100,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,83	0,12	0,03	10,88	3,39	0,010	0,016	1,29	9,48	0,09			5,00	14,3	1,2	1146,0	
117-P	07.10.92	mg/l	19,5	5,0	0,08	219,0	49,9	<0,01	0,00	39,9	485,2	8,30	0,066		305,1	7,6	22,0	1142,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,85	0,13		10,93	4,10			1,13	10,09	0,13	0,001		5,00	15,0	1,8	1071,5	
117-P	25.05.93	mg/l	22,1	5,0	<0,05	211,2	40,4		0,07	47,2	432,7	<0,40	0,013	6,0	299,0	8,2	8,8	1070,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,96	0,13		10,54	3,32		0,003	1,33	9,00			0,20	4,90	13,9	1,3	1057,0	
117-P	19.05.94	mg/l	21,0	6,0	0,04	150,3	3,6		0,12	50,0	312,0	1,70	0,006	0,0	281,0	8,1		830,0	SO4-HCO3-Ca
		mg-ekv/l	0,91	0,15		7,50	0,30		0,005	1,41	6,49	0,03			4,61	7,8	1,9	792,0	
117-P	23.08.94	mg/l	156,5	6,0	<0,03	130,0	42,4		0,05	63,0	507,0	0,94	0,006	0,0	336,0	8,1		1240,0	SO4-HCO3-Na-Ca-Mg
		mg-ekv/l	6,81	0,15		6,49	3,49		0,002	1,78	10,55	0,02			5,51	10,0	1,6	1220,0	
117-P	10.01.95	mg/l	69,0		0,46	196,0	34,0		0,02	70,1	381,0	0,27	0,003		347,6	8,1		1098,4	SO4-HCO3-Ca
		mg-ekv/l	3,00		0,03	9,78	2,79		0,001	1,98	7,92				5,70	12,6	1,5	1048,0	
117-P	13.06.95	mg/l	87,4		0,11	158,0	42,5		0,03	45,3	420,0	1,65	0,002		159,0	7,7		914,0	SO4-HCO3-Ca-Na+K-Mg
		mg-ekv/l	3,80		0,01	7,88	3,49		0,001	1,28	8,74	0,03			2,61	11,4		978,0	
117-P	08.08.95	mg/l	36,8		0,11	160,0	29,2		0,03	34,4	370,0	0,31	0,002		104,0	8,1		734,9	SO4-Ca
		mg-ekv/l	1,60		0,01	7,98	2,40		0,001	0,97	7,70				1,71	10,4		752,0	
117-P	12.12.95	mg/l	29,9		0,09	188,0	36,5		0,02	41,5	410,0	0,35	0,003		122,0	8,1		828,4	SO4-Ca-Mg
		mg-ekv/l	1,30			9,38	3,00		0,001	1,17	8,53	0,01			2,00	12,4		941,0	
117-P	09.01.96	mg/l	6,9		0,06	236,0	36,5		0,03	49,6	450,0	1,79	0,002		131,0	8,0		911,9	SO4-Ca
		mg-ekv/l	0,30			11,78	3,00		0,001	1,40	9,36	0,03			2,15	14,8		1034,0	
117-P	11.06.96	mg/l	66,7		0,07	160,0	21,9		0,17	25,1	380,0	1,75	0,013		125,0	7,6		780,7	SO4-Ca-Na+K
		mg-ekv/l	2,90			7,98	1,80		0,008	0,71	7,90	0,03			2,05	9,8		808,0	
117-P	27.08.96	mg/l	64,4		0,03	192,0	38,9		0,01	70,9	442,0	0,66	0,023		134,0	7,8		942,9	SO4-Ca-Mg
		mg-ekv/l	2,80			9,58	3,20			2,00	9,19	0,01			2,20	12,8		980,0	
117-P	25.04.00	mg/l	33,3		0,08	216,4	29,2			44,0	428,0	0,52	0,004		274,4	8,0		1025,9	SO4-HCO3-Ca
		mg-ekv/l	1,45			10,80	2,40			1,24	8,90	0,01			4,50	13,2	2,0	956,0	
117-P	26.09.00	mg/l	105,8		0,03	128,3	26,8			38,0	343,0	0,01			304,9	8,1		946,7	SO4-HCO3-Ca-Na+K
		mg-ekv/l	4,60			6,40	2,20			1,07	7,13				5,00	8,8	1,1	880,0	
117-P	12.12.00	mg/l	69,2			184,4	31,6			38,0	410,0	0,60			317,1	8,0		1050,9	SO4-HCO3-Ca
		mg-ekv/l	3,01			9,20	2,60			1,07	8,53	0,01			5,20	11,8	1,1	950,0	
117-P	13.02.01	mg/l	95,6			132,3	56,0			26,1	448,0	0,12			323,2	8,2		1081,3	SO4-HCO3-Ca-Mg-Na+K
		mg-ekv/l	4,16			6,60	4,60			0,74	9,32				5,30	11,2	1,1	992,0	
Aidu open-cast																			
120-P	14.05.85	mg/l	12,0	7,0	0,45	218,2	41,0			26,2	475,8	13,30	0,010		280,7	7,8	4,4	1084,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,52	0,18	0,02	10,89	3,37			0,74	9,90	0,21			4,60	14,3	3,4	997,0	
120-P	24.07.85	mg/l	12,0	7,2	<0,05	185,2	40,5	0,26	0,36	26,2	407,4	10,20	<0,003		280,7	7,6	19,8	980,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,52	0,18		9,24	3,33	0,009	0,016	0,74	8,47	0,16			4,60	12,6	3,5	914,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	Hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
120-P	27.05.86	mg/l	12,0	7,6	<0,05	234,3	51,9		0,03	25,2	539,9	20,00	0,076	6,0	268,5	7,3		1170,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,52	0,19		11,69	4,27		0,001	0,71	11,23	0,32	0,002	0,20	4,40	16,0	5,0		
120-P	05.06.87	mg/l	10,0	6,4	0,04	230,5	46,5			27,3	523,0	13,30	<0,003		280,7	7,6	8,8	1145,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,43	0,16		11,50	3,82			0,77	10,88	0,21			4,60	15,3	1,5	1183,5	
120-P	06.08.87	mg/l	15,4	9,0	<0,05	230,3	58,9	0,07	0,11	30,5	605,7	17,00	0,130	6,0	244,1	7,9	4,4	1220,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,67	0,23		11,49	4,84	0,003	0,005	0,86	12,60	0,27	0,003	0,20	4,00	16,3	3,8	1300,0	
120-P	15.04.88	mg/l	11,5	8,0	0,54	254,1	53,4		0,08	27,3	626,3	25,90	0,540		256,3	7,6	8,8	1270,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,50	0,20	0,03	12,68	4,39		0,004	0,77	13,03	0,42	0,012		4,20	17,1	3,5	1216,5	
120-P	24.08.88	mg/l	12,2	7,5	0,48	204,4	47,4	0,06	0,06	31,2	424,0	7,50	0,314		274,6	7,7	44,0	1010,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,53	0,19	0,03	10,20	3,90	0,002	0,003	0,88	8,82	0,12	0,007		4,50	14,1	3,5	917,0	
120-P	17.05.89	mg/l	11,5	7,6	<0,05	220,4	51,0		0,03	25,2	570,3	10,40	0,056		231,9	7,7	11,0	1140,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,50	0,19		11,00	4,19		0,001	0,71	11,86	0,17	0,001		3,80	15,2	3,9	1110,0	
120-P	13.07.89	mg/l	12,9	8,0	<0,05	227,9	55,5	0,09	0,12	31,9	540,7	12,50	0,666		286,8	7,7	11,0	1180,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,56	0,20		11,37	4,56	0,003	0,005	0,90	11,25	0,20	0,014		4,70	15,9	2,2	1047,5	
120-P	17.04.90	mg/l	9,5	7,5	<0,05	284,0	63,2		0,08	25,5	707,0	3,60	0,065	12,0	256,3	7,9	31,0	1380,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,41	0,19		14,17	5,20		0,004	0,72	14,71	0,06	0,001	0,40	4,20	19,4	1,6	1364,0	
120-P	24.07.90	mg/l	11,0	8,0	0,22	239,3	53,1		0,07	29,4	571,6	17,20	0,168		280,9	7,7	4,4	1220,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,48	0,20	0,01	11,94	4,36		0,003	0,83	11,89	0,28	0,004		4,61	16,3	4,5	1220,5	
120-P	06.06.91	mg/l	10,0	7,2	<0,05	239,3	55,4		0,12	30,8	565,8	6,50	0,018		262,4	7,9	6,6	1180,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,43	0,18		11,94	4,55		0,005	0,87	11,77	0,10			4,30	16,5	2,4	1181,5	
120-P	09.07.91	mg/l	10,5	6,8	<0,05	245,5	52,3	0,22	0,28	26,6	576,1	7,00	<0,003	12,0	268,5	7,3		1210,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,46	0,17		12,25	4,30	0,008	0,013	0,75	11,98	0,11		0,40	4,40	16,6	2,1	1125,0	
120-P	19.05.94	mg/l	7,0	4,0	<0,03	238,5	4,9		0,07	21,0	344,0	4,20	0,090	0,0	299,0	8,3		930,0	SO4-HCO3-Ca
		mg-ekv/l	0,30	0,10		11,90	0,40		0,003	0,59	7,16	0,07	0,002		4,90	12,3	1,5	895,0	
120-P	23.08.94	mg/l	94,5	5,5	<0,03	136,0	38,9		0,11	20,0	440,0	0,52	0,042	0,0	275,0	8,0		1010,0	SO4-HCO3-Ca-Na-Mg
		mg-ekv/l	4,11	0,14		6,79	3,20		0,005	0,56	9,15	0,01	0,001		4,51	10,0	2,2	1149,0	
120-P	25.01.00	mg/l	448,6		0,15	286,6	53,5		0,11	23,5	670,0	1,31	0,001		304,9	8,0		1788,7	SO4-HCO3-Na+K-Ca
		mg-ekv/l	19,52		0,01	14,30	4,40		0,005	0,66	13,94	0,02			5,00	18,7	1,7	1396,0	
120-P	02.05.00	mg/l	449,2		0,15	256,5	43,8			27,8	671,0	2,89	0,003		347,6	8,1		1798,9	SO4-HCO3-Na+K-Ca
		mg-ekv/l	19,54		0,01	12,80	3,60			0,78	13,96	0,05			5,70	16,4	1,3	1542,0	
120-P	22.08.00	mg/l	411,1		0,15	172,3	83,9			36,2	587,0	3,84	0,005		341,5	8,3		1636,0	SO4-HCO3-Na+K-Ca-Mg
		mg-ekv/l	17,88		0,01	8,60	6,90			1,02	12,21	0,06			5,60	15,5	1,2	1220,0	
120-P	17.10.00	mg/l	385,5			120,2	70,6			25,3	523,0	4,00			359,8	8,2		1488,4	SO4-HCO3-Na+K-Ca
		mg-ekv/l	16,77			6,00	5,80			0,71	10,88	0,06			5,90	11,8	1,0	1300,0	
120-P	13.02.01	mg/l	396,4			200,4	77,9			29,5	566,0	4,33			341,5	8,3		1615,9	SO4-HCO3-Na+K-Ca
		mg-ekv/l	17,24			10,00	6,40			0,83	11,77	0,07			5,60	16,4	2,5	1204,0	
120-P	29.01.02	mg/l	427,1			278,7	64,5			26,0	660,0	2,40			317,1	8,0		1775,8	SO4-HCO3-Na+K-Ca
		mg-ekv/l	18,58			13,91	5,30			0,73	13,73	0,04			5,20	18,9	0,9	1290,0	
120-P	04.06.02	mg/l	372,4			218,4	63,3			26,0	568,0	2,00			280,5	8,4		1530,6	SO4-HCO3-Na+K-Ca
		mg-ekv/l	16,20			10,90	5,20			0,73	11,81	0,03			4,60	16,1	1,3	1120,0	
120-P	24.09.02	mg/l	372,2			174,3	76,6			23,0	556,0	1,60			298,8	8,0		1502,6	SO4-HCO3-Na+K-Ca
		mg-ekv/l	16,19			8,70	6,30			0,65	11,56	0,03			4,90	15,0	1,0	1150,0	
Viru mine																			
123-P	18.05.72	mg/l	23,9		<0,05	133,3	51,8		0,30	21,6	216,9	2,00	0,010		400,1	7,7		850,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,04			6,65	4,26		0,013	0,61	4,51	0,03			6,56	10,9	3,3	683,5	
123-P	20.04.73	mg/l	35,6		0,10	144,1	50,3			37,6	264,2	1,00	<0,003		384,4	7,3		917,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,55		0,01	7,19	4,13			1,06	5,50	0,02			6,30	11,3	3,4	775,5	
123-P	16.04.74	mg/l	6,7		<0,05	193,0	54,0			14,5	324,3	<0,40	0,150		433,1	7,8		1026,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,29			9,63	4,44			0,41	6,75		0,003		7,10	14,1	4,1	834,5	
123-P	03.09.74	mg/l	19,2		<0,05	149,1	51,3			25,5	250,6	<0,40	<0,003		384,2	8,0		880,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,84			7,44	4,22			0,72	5,21				6,30	11,7	4,3	712,5	
123-P	08.04.75	mg/l	30,4		0,20	134,5	39,9		0,30	16,0	249,0	5,00	0,070		329,3	7,6		800,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,32		0,01	6,71	3,28		0,013	0,45	5,18	0,08	0,002		5,40	10,0	5,6	670,5	
123-P	23.03.76	mg/l	20,0	10,6	0,10	124,5	49,1		0,30	39,0	282,7	1,00	0,010		317,1	8,0		840,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,27	0,01	6,21	4,04		0,013	1,10	5,88	0,02			5,20	10,3	5,8	773,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	Hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
123-P	13.04.76	mg/l	28,5		0,10	157,9	56,4		0,40	30,1	329,2	3,00	0,010		341,3	7,9		950,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,24		0,01	7,88	4,64		0,018	0,85	6,85	0,05			5,60	12,5	3,7	842,0	
123-P	06.05.77	mg/l	8,5	6,9	<0,05	133,7	47,9		0,30	21,3	373,6	1,00	0,070		170,8	7,8		760,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,37	0,18		6,67	3,94		0,013	0,60	7,77	0,02	0,002		2,80	10,6	6,9	747,0	
123-P	16.04.79	mg/l	16,7	7,0	0,10	201,6	47,6			30,5	385,2	3,00	0,010		360,0	7,9		1052,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,73	0,18	0,01	10,06	3,91			0,86	8,01	0,05			5,90	14,0	5,2	927,0	
123-P	14.08.79	mg/l	210,0	10,6	0,15	94,0	32,2		0,30	226,5	198,3	2,00	5,000		372,2	7,0		1150,0	Cl-HCO3-SO4-Na-Ca
		mg-ekv/l	9,14	0,27	0,01	4,69	2,65		0,013	6,39	4,12	0,03	0,109		6,10	7,3	3,1	1138,5	
123-P	13.04.80	mg/l	21,0	7,8	0,10	189,8	57,0		0,30	47,9	452,1	2,00	0,050		311,2	7,8		1090,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,91	0,20	0,01	9,47	4,69		0,013	1,35	9,40	0,03	0,001		5,10	14,2	2,9	941,0	
123-P	20.11.80	mg/l	111,0	16,0	1,60	82,0	40,1	2,40	3,30	132,6	0,0	30,00	1,500		158,6	7,8		580,0	Cl-HCO3-Na-Ca-Mg
		mg-ekv/l	4,83	0,41	0,09	4,09	3,30	0,086	0,148	3,74		0,48	0,033		2,60	7,4	2,4	788,0	
123-P	12.04.81	mg/l	4,8	3,5	0,15	173,4	60,8			49,6	438,2	6,90	0,020		262,4	7,0		1000,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,21	0,09	0,01	8,65	5,00			1,40	9,11	0,11			4,30	13,7	4,8	905,5	
123-P	09.08.81	mg/l	24,8	7,8	0,15	169,7	54,4			37,6	400,4	6,90	0,020		329,5	7,0		1031,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,08	0,20	0,01	8,47	4,47			1,06	8,33	0,11			5,40	12,9	4,8	912,5	
123-P	30.03.82	mg/l	6,4	9,5	0,10	134,5	56,4			12,4	329,6	10,20	0,200	12,0	286,8	7,9		865,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,28	0,24	0,01	6,71	4,64			0,35	6,86	0,16	0,004	0,40	4,70	11,4	3,9	793,0	
123-P	07.09.82	mg/l	8,0	11,0	0,40	124,8	58,2			12,1	245,7	0,50	0,010		378,3	7,7	2,2	848,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,35	0,28	0,02	6,23	4,78			0,34	5,11	0,01			6,20	11,0	9,4	705,5	
123-P	25.05.83	mg/l	7,5	10,0	0,20	148,7	68,9		0,30	14,2	371,6				378,3	7,5	4,4	1010,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,33	0,26	0,01	7,42	5,66		0,013	0,40	7,73				6,20	13,1	3,7	900,0	
123-P	10.08.83	mg/l	8,4	12,0	0,30	119,6	62,6		0,30	14,2	291,3	3,10	0,900		347,8	7,6	11,0	890,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,37	0,31	0,02	5,97	5,15		0,013	0,40	6,06	0,05	0,020		5,70	11,1	2,9	711,0	
123-P	16.04.84	mg/l	5,0	9,0	0,15	205,6	71,6		0,30	11,0	547,7	13,30	0,150	6,0	317,3	7,7	2,2	1190,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,22	0,23	0,01	10,26	5,89		0,013	0,31	11,39	0,21	0,003	0,20	5,20	16,1	4,6	1144,0	
123-P	12.09.84	mg/l	8,0	9,3	0,20	129,1	67,0		0,30	16,7	327,1	2,20		12,0	341,7	7,9	4,4	920,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,35	0,24	0,01	6,44	5,51		0,013	0,47	6,80	0,04		0,40	5,60	11,9	5,4	746,0	
123-P	20.04.85	mg/l	6,3	8,0	<0,05	160,1	60,0			11,3	356,4	9,30	0,030	6,0	360,0	7,9	6,6	980,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,27	0,20		7,99	4,93			0,32	7,41	0,15	0,001	0,20	5,90	12,9	2,2	865,0	
123-P	23.07.85	mg/l	7,0	11,5	0,10	151,7	68,8	0,10	0,10	14,9	356,4	2,20			396,6	7,6	24,2	1020,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,30	0,29	0,01	7,57	5,66	0,004	0,004	0,42	7,41	0,04			6,50	13,2	4,2	903,0	
123-P	08.04.86	mg/l	8,0	9,6	<0,05	182,0	63,9			13,5	421,4	7,50	0,050		378,3	7,5	4,4	1092,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,35	0,25		9,08	5,25			0,38	8,77	0,12	0,001		6,20	14,3	6,6	964,5	
123-P	01.09.86	mg/l	6,7	10,0	<0,05	141,5	69,2	0,06	0,10	18,4	353,2	1,20	0,018	12,0	353,9	7,8	8,8	980,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,29	0,26		7,06	5,69	0,002	0,004	0,52	7,35	0,02		0,40	5,80	12,8	9,3	806,5	
123-P	06.05.87	mg/l	6,4	8,5	0,12	195,4	66,8			18,4	483,5	10,20			341,7	7,7	19,8	1148,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,28	0,22	0,01	9,75	5,49			0,52	10,06	0,16			5,60	15,2	4,9	1073,0	
123-P	21.07.87	mg/l	8,0	10,0	<0,05	150,7	60,3	0,06	0,09	12,8	339,1	1,90	0,030	12,0	323,4	7,8	6,6	930,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,35	0,26		7,52	4,96	0,002	0,004	0,36	7,05	0,03	0,001	0,40	5,30	12,5	4,1	813,5	
123-P	03.03.88	mg/l	8,5	10,2	<0,05	119,8	58,3			11,0	298,7	1,50			373,0	7,7	8,7	888,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,37	0,26		5,98	4,79			0,31	6,21	0,02			6,12	10,8	3,7	686,5	
123-P	12.07.88	mg/l	9,3	10,9	<0,05	146,3	61,4			17,4	325,0	0,90			366,1	7,2	15,4	944,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,40	0,28		7,30	5,05			0,49	6,76	0,01			6,00	12,4	3,2	835,5	
123-P	12.07.89	mg/l	12,9	11,4	<0,05	140,3	61,7	0,10	0,15	23,4	325,9	2,40			372,2	7,8	8,8	960,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,56	0,29		7,00	5,07	0,004	0,007	0,66	6,78	0,04			6,10	12,1	2,8	793,0	
123-P	03.04.90	mg/l	5,6	9,0	<0,05	165,5	62,3			10,6	379,8	7,70	0,012	6,0	353,9	8,1	2,2	1008,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,24	0,23		8,26	5,12			0,30	7,90	0,12		0,20	5,80	13,4	4,2	882,0	
123-P	17.09.90	mg/l	10,0	10,7	0,28	158,3	65,8	0,12	0,20	9,2	360,1	2,40	0,062		378,3	7,9	13,2	1000,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,43	0,27	0,02	7,90	5,41	0,004	0,009	0,26	7,49	0,04	0,001		6,20	13,3	7,3	885,0	
123-P	06.06.91	mg/l	8,0	10,0	<0,05	143,1	60,8			16,3	408,6	3,50			280,7	7,9	6,6	938,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,35	0,26		7,14	5,00			0,46	8,50	0,06			4,60	12,1	2,8	944,0	
123-P	18.06.92	mg/l	7,3	8,0	1,70	144,7	65,3		0,03	10,0	359,2	3,40			366,1	7,7	6,6	970,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,32	0,20	0,09	7,22	5,37		0,001	0,28	7,47	0,05			6,00	12,6	3,6	868,0	
123-P		mg/l	8,0	10,0	<0,05	159,3	65,9		0,11	17,0	386,0	0,40	0,025		372,2	8,4	13,2	1030,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	Hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
	26.05.93	mg-ekv/l	0,35	0,26		7,95	5,42		0,005	0,48	8,03	0,01	0,001		6,10	13,4	4,0	915,5	SO4-HCO3-Ca-Mg
123-P	17.05.94	mg/l	18,5	8,0	0,10	120,2	7,3		0,43	39,0	490,0	0,97	0,006	0,0	323,0	8,2		1010,0	SO4-HCO3-Ca
		mg-ekv/l	0,80	0,20	0,01	6,00	0,60		0,019	1,10	10,19	0,02			5,30	6,6	3,6	989,0	
123-P	16.08.94	mg/l	54,0	8,5	0,13	44,1	70,5		0,17	7,0	340,0	1,23	0,016	0,0	183,0	8,2		720,0	SO4-HCO3-Mg-Na-Ca
		mg-ekv/l	2,35	0,22	0,01	2,20	5,80		0,008	0,20	7,07	0,02			3,00	8,0	2,6	905,0	
123-P	15.01.02	mg/l	38,4			136,3	53,5			20,0	356,0	0,50			298,8	8,0		903,5	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,67			6,80	4,40			0,56	7,40	0,01			4,90	11,2	2,1	806,0	
123-P	02.04.02	mg/l	23,2			140,3	58,4			10,0	313,0	1,20			365,9	8,4		911,9	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,01			7,00	4,80			0,28	6,51	0,02			6,00	11,8	1,2	784,0	
123-P	10.09.02	mg/l	60,9			198,4	43,8			9,0	490,0	0,52			347,6	8,4		1150,2	SO4-HCO3-Ca-Mg
		mg-ekv/l	2,65			9,90	3,60			0,25	10,19	0,01			5,70	13,5	1,1	1038,0	
Kiviõli mine																			
107-P	03.09.74	mg/l	118,6		0,70	199,4	32,9			105,3	530,0	<0,40	0,100		176,8	7,4		1163,8	SO4-Ca-Na+K
		mg-ekv/l	5,16		0,04	9,95	2,70			2,97	11,02		0,002		2,90	12,7	68,0		
107-P	06.05.75	mg/l	112,7		0,10	49,3	16,8			210,6	0,0	<0,40	<0,003		158,5	8,0		548,0	Cl-HCO3-Na+K-Ca
		mg-ekv/l	4,90		0,01	2,46	1,38			5,94					2,60	3,8	0,2		
107-P	22.08.75	mg/l	60,0		0,15	189,0	41,1			84,0	411,5	<0,40	<0,010		249,9	7,7		1035,6	SO4-HCO3-Ca-Mg
		mg-ekv/l	2,61		0,01	9,43	3,38			2,37	8,56				4,10	12,8	9,7		
107-P	13.04.76	mg/l	80,9		1,00	226,6	36,8		1,60	88,6	588,4	7,00	0,600		170,6	7,9		1202,1	SO4-Ca
		mg-ekv/l	3,52		0,06	11,31	3,02		0,086	2,50	12,24	0,11	0,013		2,80	14,3	14,4		
107-P	23.08.76	mg/l	50,0	58,8	2,00	175,2	31,2			127,6	461,7	<0,40	0,400		158,0	7,3		1064,9	SO4-Cl-Ca
		mg-ekv/l	2,17	1,51	0,11	8,74	2,56			3,60	9,60		0,009		2,59	11,3			
107-P	04.05.77	mg/l	87,8			231,3	35,8			130,3	513,6	<0,40	0,041		241,0			1239,8	SO4-HCO3-Ca-Na+K
		mg-ekv/l	3,82			11,54	2,94			3,67	10,68		0,001		3,95	14,5	31,5		
107-P	16.04.79	mg/l	35,2	42,8	1,25	205,2	31,4			67,0	464,2	<0,40	0,150		244,1	7,9		1091,3	SO4-HCO3-Ca
		mg-ekv/l	1,53	1,10	0,07	10,24	2,58			1,89	9,66		0,003		4,00	12,8	13,0		
107-P	15.08.79	mg/l	167,0	95,0	0,70	182,0	33,4			278,7	585,6	4,00	0,010		115,9	7,2		1462,3	SO4-Cl-Ca-Na
		mg-ekv/l	7,26	2,43	0,04	9,08	2,75			7,86	12,18	0,06			1,90	11,8	52,8		
107-P	28.04.80	mg/l	87,8		0,30	215,4	36,7			77,3	525,5	4,00	1,300		256,3	7,5		1204,6	SO4-HCO3-Ca-Na+K
		mg-ekv/l	3,82		0,02	10,75	3,02			2,18	10,93	0,06	0,028		4,20	13,8	12,0		
107-P	27.11.80	mg/l	10,0	7,0	0,20	172,1	38,2			31,2	357,2	5,00	0,060		244,1	7,8		865,1	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,43	0,18	0,01	8,59	3,14			0,88	7,43	0,08	0,001		4,00	11,7	4,5		
107-P	12.04.81	mg/l	6,5	6,0	<0,05	142,5	29,2			28,4	281,1	14,20	<0,003		244,1	7,6		752,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,28	0,15		7,11	2,40			0,80	5,85	0,23			4,00	9,5	9,1		
107-P	20.08.81	mg/l	14,6	8,5	0,20	175,2	34,6	<0,01		42,2	342,0	8,80	<0,010		274,4	7,7		900,5	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,64	0,22	0,01	8,74	2,84			1,19	7,11	0,14			4,50	11,6	7,6		
107-P	27.05.82	mg/l	12,5	8,8	0,10	174,2	34,2			29,8	351,4	12,50	0,250		280,5	8,2		904,2	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,54	0,23	0,01	8,69	2,81			0,84	7,31	0,20	0,005		4,60	11,5	5,8		
107-P	14.09.82	mg/l	90,0	10,0	0,15	173,4	38,9	<0,01		68,4	311,1	<0,40	<0,003		323,2	7,8		1015,2	SO4-HCO3-Ca-Na
		mg-ekv/l	3,91	0,26	0,01	8,65	3,20			1,93	6,47				5,30	11,9	4,7		
107-P	25.05.83	mg/l	13,0	7,5	0,20	165,1	33,8			28,7	304,9	2,70	0,010		280,7	8,0		836,6	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,57	0,19	0,01	8,24	2,78			0,81	6,34	0,04			4,60	11,0	3,5		
107-P	22.08.83	mg/l	17,1	8,7	0,20	156,9	43,1	<0,01		45,0	314,8	1,80	<0,003		311,2	7,9		898,8	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,74	0,22	0,01	7,83	3,54			1,27	6,55	0,03			5,10	11,4	2,2		
107-P	13.06.84	mg/l	16,7	10,5	0,15	202,4	40,5			49,6	399,2	5,80	0,010		317,3	8,2		1042,2	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,73	0,27	0,01	10,10	3,33			1,40	8,30	0,09			5,20	13,4	5,3		
107-P	12.09.84	mg/l	20,0	8,0	0,15	177,6	40,7	<0,01		53,9	325,0	3,50	<0,003	12,0	299,0	7,9		939,9	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,87	0,20	0,01	8,86	3,35			1,52	6,76	0,06		0,40	4,90	12,2	4,7		
107-P	13.05.85	mg/l	10,0	7,5	0,20	170,1	32,6			29,8	315,2	13,30	<0,003		280,7	7,5		859,4	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,43	0,19	0,01	8,49	2,68			0,84	6,56	0,21			4,60	11,2	8,8		
107-P	05.07.85	mg/l	17,5	11,1	0,10	188,2	41,7			52,1	357,6	2,90	<0,003	6,0	317,3	7,8		994,5	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,76	0,28	0,01	9,39	3,43			1,47	7,44	0,05		0,20	5,20	12,8	4,3		
107-P	22.05.86	mg/l	14,2	8,3	0,30	193,6	31,5		0,12	31,2	347,7	3,30	0,072		323,4	7,9		953,7	SO4-HCO3-Ca
		mg-ekv/l	0,62	0,21	0,02	9,66	2,59		0,006	0,88	7,23	0,05	0,002		5,30	12,3	16,0		

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	Hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
107-P	16.07.86	mg/l	26,7	18,7	1,02	176,2	38,9	0,68	0,68	72,3	343,2	2,70	0,024	24,0	256,3	8,6		960,7	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,16	0,48	0,06	8,79	3,20	0,024	0,024	2,04	7,14	0,04	0,001	0,80	4,20	12,0	2,9		
107-P	05.06.87	mg/l	16,3	16,7	0,80	203,6	35,2			43,2	334,5	14,00	<0,003		353,9	7,7		1018,2	SO4-HCO3-Ca
		mg-ekv/l	0,71	0,43	0,04	10,16	2,89			1,22	6,96	0,23			5,80	13,1	8,0		
107-P	07.07.87	mg/l	19,0	9,3	<0,05	189,4	39,1	0,13	0,16	50,3	355,1	3,60	0,018		341,7	7,7		1007,7	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,83	0,24		9,45	3,21	0,005	0,007	1,42	7,39	0,06			5,60	12,7	3,7		
107-P	1988	mg/l							0,08	53,9	732,0	1,64				7,8			-
		mg-ekv/l							0,003	1,52	15,23	0,03				21,0		1610,0	
107-P	1989	mg/l							0,13	35,2	1241,0	1,01				7,4			-
		mg-ekv/l							0,006	0,99	25,81	0,02				29,8		2250,0	
107-P	1990	mg/l							0,06	45,9	610,0	1,19				7,8			-
		mg-ekv/l							0,003	1,29	12,69	0,02				17,7		1290,0	
107-P	1991	mg/l							0,12	36,7	415,0	0,36				7,7			-
		mg-ekv/l							0,005	1,03	8,63	0,01				13,9		1050,0	
107-P	1992	mg/l							0,02	32,5	354,0	0,08				7,8			-
		mg-ekv/l							0,001	0,92	7,36					12,4		980,0	
107-P	1993	mg/l							0,03	43,0	295,0	2,99				7,8			-
		mg-ekv/l														11,8		826,0	
107-P	25.01.00	mg/l	218,9		0,31	126,3	26,8		0,37	20,0	234,0	1,29	0,004		280,5	7,9		908,4	SO4-HCO3-Na+K-Ca
		mg-ekv/l	9,52		0,02	6,30	2,20		0,017	0,56	4,87	0,02			4,60	8,5	2,9	624,0	
107-P	02.05.00	mg/l	218,4		0,13	138,3	35,3			17,4	293,0	0,75	0,006		213,4	8,1		916,7	SO4-HCO3-Na+K-Ca
		mg-ekv/l	9,50		0,01	6,90	2,90			0,49	6,09	0,01			3,50	9,8	2,3	664,0	
107-P	22.08.00	mg/l	246,4		0,13	120,2	48,7			21,7	341,0	3,90	0,006		219,5	8,3		1001,6	SO4-HCO3-Na+K-Ca
		mg-ekv/l	10,72		0,01	6,00	4,00			0,61	7,09	0,06			3,60	10,0	3,7	728,0	
107-P	17.10.00	mg/l	212,2			104,2	42,6			18,1	231,0	4,32			268,3	8,4		880,7	SO4-HCO3-Na+K-Ca
		mg-ekv/l	9,23			5,20	3,50			0,51	4,80	0,07			4,40	8,7	2,8	780,0	
107-P	13.02.01	mg/l	226,2			120,2	48,7			26,1	267,0	4,70			250,0	8,4		942,9	SO4-HCO3-Na+K-Ca
		mg-ekv/l	9,84			6,00	4,00			0,74	5,55	0,08			4,10	10,0	1,9	606,0	
107-P	29.01.02	mg/l	191,5			90,2	51,1			32,0	182,0	0,68			256,1	8,5		803,6	HCO3-SO4-Na+K-Ca-Mg
		mg-ekv/l	8,33			4,50	4,20			0,90	3,79	0,01			4,20	8,7	1,6	526,0	
107-P	04.06.02	mg/l	191,7			100,2	31,6			25,0	163,0	0,90			286,6	8,4		799,1	HCO3-SO4-Na+K-Ca
		mg-ekv/l	8,34			5,00	2,60			0,70	3,39	0,01			4,70	7,6	1,8	590,0	
107-P	24.09.02	mg/l	194,0			153,7	24,3			21,0	200,0	1,00			304,9	8,1		898,9	HCO3-SO4-Na+K-Ca
		mg-ekv/l	8,44			7,67	2,00			0,59	4,16	0,02			5,00	9,7	1,2	588,0	

Koostas: V.Savva

Table . The chemical composition of groundwater of Lasnamäe–Kunda aquifer in mining areas of Oil Shale Basin

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
Kukruse, Käva and mine 2 areas																			
3656	26.06.85	mg/l	9,5	5,0	0,40	181,4	46,1		0,050	20,6	387,6	0,90	0,010		317,3	7,6	8,8	970,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,41	0,13	0,02	9,05	3,79		0,002	0,58	8,06	0,01			5,20	12,8	0,9	875,0	
3721	22.11.85	mg/l	10,6	4,7		207,0	70,2			56,0	564,6	4,40			329,5		4,4	1250,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,46	0,12		10,33	5,77			1,58	11,74	0,07			5,40	16,1	3,8	1617,5	
4038	30.10.85	mg/l	7,0	8,0		124,3	65,3			22,7	355,5		0,030		292,9	7,8		880,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,30	0,20		6,20	5,37			0,64	7,39		0,001		4,80	11,6	2,1	774,0	
4039	07.05.86	mg/l	37,0	11,7		65,9	30,3			46,5	94,6				317,3	8,0	11,0	620,0	HCO3-SO4-Ca-Mg-Na
		mg-ekv/l	1,61	0,30		3,29	2,49			1,31	1,97				5,20	5,8	1,6	461,5	
13476	03.12.90	mg/l	7,3	5,5	0,33	139,3	66,3		0,180	40,8	370,4		0,019		282,7	7,8	15,4	920,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,32	0,14	0,02	6,95	5,45		0,010	1,15	7,70				4,64	12,4	0,3	929,0	
13508	28.12.90	mg/l	12,0	10,0		99,2	60,2			25,9	330,0				317,3	8,0	17,6	850,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,52	0,26		4,95	4,95			0,73	6,86				5,20	9,9	4,1	783,0	
13513	19.07.90	mg/l	8,0	7,0		136,5	75,3			33,0	369,5		0,143		341,7	7,7		980,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,35	0,18		6,81	6,19			0,93	7,69		0,003		5,60	13,0	1,6	982,0	
13514	28.07.90	mg/l	4,7	5,3	0,16	98,0	58,1			18,4	249,8				317,2	7,9		760,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,20	0,14	0,01	4,89	4,78			0,52	5,20				5,20	9,7	1,8	763,0	
13515	21.07.90	mg/l	27,0	7,0		99,0	57,5			51,1	237,8				305,1	7,8		800,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,17	0,18		4,94	4,73			1,44	4,95				5,00	9,7	3,4	795,0	
13524	15.06.95	mg/l	42,6	15,6	0,60	148,3	46,2	0,305	0,380	23,5	301,0	3,65	0,014		396,5	8,0		980,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,85	0,40	0,03	7,40	3,80	0,011	0,017	0,66	6,26	0,06			6,50	11,2	2,6	816,0	
13589	25.04.89	mg/l	7,4	12,5		43,1	60,5			14,9	160,1			12,0	250,2	8,4		570,0	HCO3-SO4-Mg-Ca
		mg-ekv/l	0,32	0,32		2,15	4,97			0,42	3,33			0,40	4,10	7,1	0,9	463,0	
13596	13.04.89	mg/l	15,0	8,9		136,7	71,7			38,6	458,4	6,20			213,6	8,2	4,4	960,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,65	0,23		6,82	5,89			1,09	9,53	0,10			3,50	12,7	0,6	916,0	
13611	20.01.89	mg/l	13,8	6,0		41,9	20,4		0,060	10,3	10,3				256,3	7,8		370,0	HCO3-Ca-Mg
		mg-ekv/l	0,60	0,15		2,09	1,68		0,003	0,29	0,21				4,20	3,8	2,7	238,0	
14388	15.01.98	mg/l	30,1		0,05	95,2	50,5		0,720	27,0	140,0	0,46	0,010		400,2	7,5		749,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,31			4,75	4,15		0,032	0,76	2,91	0,01			6,56	8,9	1,1	560,0	
19618	12.02.87	mg/l	23,2		0,42	22,4	10,9			7,5		4,60	0,004		158,7			227,7	HCO3-Ca-Na+K-Mg
		mg-ekv/l	1,01		0,02	1,12	0,90			0,21		0,07			2,60	2,0	1,5	150,5	
Sompa mine area																			
3663	11.07.85	mg/l	36,0			66,7	44,2			29,8	132,5			12,0	280,7	7,8	11,0	610,0	HCO3-SO4-Mg-Ca
		mg-ekv/l	1,57			3,33	3,63			0,84	2,76			0,40	4,60	7,0	2,5	499,5	
4035	30.10.85	mg/l	8,0	11,3	0,40	72,3	65,3			14,9	187,2				366,1	7,9	2,2	730,0	HCO3-SO4-Mg-Ca
		mg-ekv/l	0,35	0,29	0,02	3,61	5,37			0,42	3,89				6,00	9,0	1,6	595,0	
12290	17.08.89	mg/l	56,2	10,0		40,7	25,9		0,040	27,7	44,4		0,006	6,0	317,3	8,1		540,0	HCO3-Na-Mg-Ca
		mg-ekv/l	2,44	0,26		2,03	2,13		0,002	0,78	0,92			0,20	5,20	4,2	1,6	382,0	
13512	01.08.90	mg/l	8,4	10,0		85,4	65,8		0,040	22,0	178,2		0,500		427,1	7,8		810,0	HCO3-SO4-Mg-Ca
		mg-ekv/l	0,37	0,26		4,26	5,41		0,002	0,62	3,71		0,011		7,00	9,7		810,0	
15483	21.06.01	mg/l	64,4		0,37	144,0	57,6		0,040	17,4	412,0		0,003		347,7	8,2		1043,5	SO4-HCO3-Ca-Mg
		mg-ekv/l	2,80		0,02	7,19	4,73		0,002	0,49	8,57				5,70	11,9	2,5	898,0	
15562	08.01.01	mg/l			0,37				0,560	15,6	351,0	0,00	0,001			8,4			-
		mg-ekv/l															2,1	812,0	
15711	14.09.01	mg/l	21,9		0,51	100,0	33,6		0,220	20,8	152,0		0,001		152,0	8,3		481,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,95		0,03	4,99	2,76		0,010	0,59	3,16				2,49	7,8	1,2	580,0	
15762	08.11.01	mg/l	18,4		0,07	104,0	14,4		0,180	28,0	115,0	4,39	0,003		244,0	8,3		528,4	HCO3-SO4-Ca
		mg-ekv/l	0,80			5,19	1,18		0,008	0,79	2,39	0,07			4,00	6,4	2,4	498,0	
15763		mg/l	82,8		0,48	120,0	24,0		0,690	15,6	300,0	0,01	0,001		305,0	8,4		848,6	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
	17.07.01	mg-ekv/l	3,60		0,03	5,99	1,97		0,031	0,44	6,24				5,00	8,0	1,2	708,0	SO4-HCO3-Ca-Na+K
15764	03.08.01	mg/l	21,4		0,24	80,0	40,8		0,290	17,4	146,0	0,65	0,004		292,8	8,0		599,6	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,93		0,01	3,99	3,35		0,013	0,49	3,04	0,01			4,80	7,3	1,5	490,0	
15765	22.08.01	mg/l	31,1		0,02	120,0	38,4		0,230	17,4	243,0		0,010		305,0	8,2		755,2	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,35			5,99	3,16		0,010	0,49	5,05				5,00	9,2	1,0	650,0	
15766	02.10.01	mg/l	64,4		0,03	122,0	21,6		1,380	17,4	289,0	0,01			256,2	8,4		772,0	SO4-HCO3-Ca-Na+K
		mg-ekv/l	2,80			6,09	1,78		0,062	0,49	6,01				4,20	7,9	2,4	647,0	
15767	24.10.01	mg/l	78,2		0,13	100,0	34,8		0,060	22,6	324,0	0,01	0,001		244,0	8,3		803,8	SO4-HCO3-Ca-Na+K-Mg
		mg-ekv/l	3,40		0,01	4,99	2,86		0,003	0,64	6,74				4,00	7,8	2,4	704,0	
15768	06.11.01	mg/l	64,4		0,09	58,0	56,4		0,040	12,2	280,0	0,04	0,001		262,3	8,4		733,5	SO4-HCO3-Mg-Ca-Na+K
		mg-ekv/l	2,80			2,89	4,64		0,002	0,34	5,82				4,30	7,5	1,2	626,0	
15769	30.10.01	mg/l	69,0		0,19	64,0	55,2		0,020	12,2	295,0	0,01	0,001		268,4	8,4		764,0	SO4-HCO3-Mg-Ca-Na+K
		mg-ekv/l	3,00		0,01	3,19	4,54		0,001	0,34	6,14				4,40	7,7	2,4	678,0	
15955	27.11.01	mg/l	29,9		0,29	84,0	21,6		0,010	23,6	126,0	0,01	0,014		244,0	8,7		529,4	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,30		0,02	4,19	1,78			0,67	2,62				4,00	6,0	3,3	430,0	
Tammiku mine area																			
3019	15.03.74	mg/l	9,1	10,8	0,15	59,5	51,8		0,300	8,9	12,0	1,00	0,500	24,0	433,2	7,4		610,0	HCO3-Mg-Ca
		mg-ekv/l	0,40	0,28	0,01	2,97	4,26		0,013	0,25	0,25	0,02	0,011	0,80	7,10	7,2	0,9	387,0	
3662	21.11.85	mg/l	14,0	8,0		78,8	47,6			18,8	168,7			6,0	292,2	7,9		640,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,61	0,20		3,93	3,91			0,53	3,51			0,20	4,79	7,8	0,8	534,5	
3662	31.10.02	mg/l	13,4	8,4	<0,05	186,6	65,4	0,660	0,660	20,6	486,4	<0,40	<0,003	<6,0	329,4	7,2	22,0	1119,2	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,58	0,22		9,31	5,38	0,024	0,030	0,58	10,12				5,40	14,7	0,9	1061,5	
4261	20.09.91	mg/l	6,9	10,3		115,2	68,7		0,050	21,3	294,6	1,40			329,5		8,8	850,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,30	0,26		5,75	5,65		0,002	0,60	6,13	0,02			5,40	11,4	1,7	855,0	
4264	27.08.91	mg/l	13,3	13,6		76,2	79,0		0,040	24,8	246,9			6,0	329,5	7,8	6,6	800,0	HCO3-SO4-Mg-Ca
		mg-ekv/l	0,58	0,35		3,80	6,49		0,002	0,70	5,14			0,20	5,40	10,3	1,2	796,3	
4266	12.09.91	mg/l	43,0	13,0		115,2	77,2		0,040	102,1	260,9		0,276		366,1	7,6	8,8	990,0	HCO3-SO4-Mg-Ca
		mg-ekv/l	1,87	0,33		5,75	6,35		0,002	2,88	5,43		0,006		6,00	12,1	1,6	990,0	
5023	20.05.93	mg/l	12,7	76,0		108,2	24,3			134,7	72,0				280,6			710,0	HCO3-Cl-Ca
		mg-ekv/l	0,55	1,95		5,40	2,00			3,80	1,50				4,60	7,4		590,0	
5133	04.11.92	mg/l	7,1	0,0		100,2	36,2			14,2	92,3				366,0			620,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,31			5,00	2,97			0,40	1,92				6,00	8,0		726,0	
5162	18.05.92	mg/l	6,9	76,2		40,0	27,9			10,3	12,4				366,1			540,0	HCO3-Mg-Ca-K
		mg-ekv/l	0,30	1,95		2,00	2,29			0,29	0,26				6,00	4,3		560,0	
5731	10.11.92	mg/l	6,9	11,3		58,1	37,7			8,1	19,0				366,0			510,0	HCO3-Mg-Ca
		mg-ekv/l	0,30	0,29		2,90	3,10			0,23	0,40				6,00	6,0		606,0	
13461	22.03.91	mg/l	7,0	11,7		36,2	70,5		0,160	19,9	320,6	3,60	0,011		292,9	7,9		770,0	SO4-HCO3-Mg-Ca
		mg-ekv/l	0,30	0,30		1,81	5,80		0,009	0,56	6,67	0,06			4,80	7,6	1,5	830,0	
13463	26.03.91	mg/l	16,3	12,2	0,42	163,3	85,0		0,160	45,4	118,1		0,005		286,8	8,0		730,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,71	0,31	0,02	8,15	6,99		0,009	1,28	2,46				4,70	15,1	1,4	1038,0	
13474	26.09.90	mg/l	15,0	12,1		58,3	53,0			47,9	33,3		0,286		402,7	8,1	2,2	630,0	HCO3-Mg-Ca
		mg-ekv/l	0,65	0,31		2,91	4,36			1,35	0,69		0,006		6,60	7,3	0,8	630,0	
13477	29.11.90	mg/l	10,0	9,5		87,2	65,1		0,100	12,8	178,2	0,70	0,005	12,0	341,7	7,8	17,6	730,0	HCO3-SO4-Mg-Ca
		mg-ekv/l	0,43	0,24		4,35	5,35		0,004	0,36	3,71	0,01		0,40	5,60	9,7	0,5	726,0	
13478	28.09.90	mg/l	53,8	11,4		95,8	68,3		0,120	111,0	169,1		0,036		317,3	7,4	35,2	830,0	HCO3-SO4-Cl-Mg-Ca
		mg-ekv/l	2,34	0,29		4,78	5,61		0,005	3,13	3,52		0,001		5,20	10,4	0,7	720,0	
13489	17.10.96	mg/l	0,8		0,01	94,2	57,1		0,280	28,0	180,0	1,03	0,030		344,6	8,0		720,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,03			4,70	4,70		0,013	0,79	3,74	0,02	0,001		5,65	9,4	1,2	622,0	
13490	15.10.96	mg/l	0,7		0,07	74,2	30,0		1,700	36,0	26,0	0,23	0,015		317,2	7,9		500,0	HCO3-Ca-Mg
		mg-ekv/l	0,03			3,70	2,47		0,076	1,02	0,54				5,20	6,2	0,4	418,0	
13497	03.05.96	mg/l	34,0	105,3	0,25	120,2	18,2		0,490	26,2	259,0	0,04	<0,001		341,6	7,8		910,0	HCO3-SO4-Ca-K
		mg-ekv/l	1,48	2,70	0,01	6,00	1,50		0,022	0,74	5,39				5,60	7,5	2,2	780,0	
13509	26.08.90	mg/l	18,1	8,0		62,5	44,9		0,150	16,3	81,1		0,042	6,0	323,4	7,9		570,0	HCO3-SO4-Mg-Ca
		mg-ekv/l	0,79	0,20		3,12	3,69		0,007	0,46	1,69		0,001	0,20	5,30	6,8	2,0	568,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
13510	27.07.90	mg/l	15,0	11,3		141,7	93,6			47,5	468,3		0,042		317,2	7,8		1100,0	SO4-HCO3-Mg-Ca
		mg-ekv/l	0,65	0,29		7,07	7,69			1,34	9,74		0,001		5,20	14,8	1,6	1104,0	
13511	24.07.90	mg/l	15,0	12,5	0,52	131,3	96,1		0,040	51,1	369,5		0,022		378,3	0,5		1060,0	SO4-HCO3-Mg-Ca
		mg-ekv/l	0,65	0,32	0,03	6,55	7,90		0,002	1,44	7,69				6,20	14,4	2,4	1064,0	
13516	25.07.90	mg/l	8,7	9,0		105,2	63,8		0,040	18,4	178,2		0,080	30,0	335,6	7,8		760,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,38	0,23		5,25	5,24		0,002	0,52	3,71		0,002	1,00	5,50	10,5	1,6	756,0	
13537	14.03.95	mg/l	6,9	58,5	0,75	100,2	36,6		0,560	100,8	40,4	<0,01	<0,001		359,9	8,1		700,0	HCO3-Cl-Ca-Mg
		mg-ekv/l	0,30	1,50	0,04	5,00	3,01		0,025	2,84	0,84				5,90	8,0	2,2	566,0	
13539	09.03.95	mg/l	14,8	23,4	0,40	100,2	26,7		0,240	17,0	106,3	0,10	<0,001		347,7	7,8		640,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,64	0,60	0,02	5,00	2,19		0,011	0,48	2,21				5,70	7,2	2,9	492,0	
13542	25.06.90	mg/l	60,0	9,0		42,7	31,0		0,140	9,2	12,0			12,0	421,0	8,0	8,8	610,0	HCO3-Na-Mg-Ca
		mg-ekv/l	2,61	0,23		2,13	2,55		0,008	0,26	0,25			0,40	6,90	4,7	0,8	606,0	
13576	20.10.89	mg/l	26,1			149,1	75,4			38,6	404,9		0,004		353,9	7,6	8,8	1060,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,14			7,44	6,20			1,09	8,42				5,80	13,6	0,8	878,0	
13577	05.07.89	mg/l	16,5	12,1		41,1	48,0		0,020	9,9	11,9	0,20		12,0	372,2	8,1		530,0	HCO3-Mg-Ca
		mg-ekv/l	0,72	0,31		2,05	3,95		0,001	0,28	0,25			0,40	6,10	6,0	1,2	346,0	
13580	25.09.89	mg/l	13,8	10,0		76,8	50,0		0,500	47,5	47,3	1,60			414,9	7,5	30,8	670,0	HCO3-Mg-Ca
		mg-ekv/l	0,60	0,26		3,83	4,11		0,027	1,34	0,98	0,03			6,80	7,9	1,8	513,0	
13582	06.06.89	mg/l	26,1			149,1	75,4			38,6	404,9				353,9	7,6	8,8	1050,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,14			7,44	6,20			1,09	8,42				5,80	13,6	0,8	878,0	
13593	15.04.89	mg/l	8,7	10,0		66,7	67,3			31,9	232,1			6,0	232,1	8,2	4,4	660,0	SO4-HCO3-Mg-Ca
		mg-ekv/l	0,38	0,26		3,33	5,53			0,90	4,83			0,20	3,81	8,9	0,7	596,5	
13594	11.04.89	mg/l	63,1	10,8		81,2	60,2			140,4	104,1		0,020	6,0	347,8	7,9	22,0	820,0	HCO3-Cl-Mg-Ca-Na
		mg-ekv/l	2,74	0,28		4,05	4,95			3,96	2,17			0,20	5,70	9,0	1,2	642,0	
13595	12.04.89	mg/l	4,9			87,6	16,0			7,5	36,2				280,7			430,0	HCO3-Ca-Mg
		mg/l	4,9			87,6	16,0			7,5	36,2				280,7			430,0	
13595	12.04.89	mg-ekv/l	0,21			4,37	1,32			0,21	0,75				4,60	5,7	6,8	355,0	
		mg-ekv/l	0,21			4,37	1,32			0,21	0,75				4,60	5,7	6,8	355,0	
13597	07.04.89	mg/l	14,6	12,0		59,5	71,1			53,5	200,8				244,1	8,3	2,2	660,0	SO4-HCO3-Mg-Ca
		mg-ekv/l	0,64	0,31		2,97	5,84			1,51	4,18				4,00	8,8	0,8	585,0	
13615	17.06.89	mg/l	12,7	11,1		47,3	49,8		0,060	26,9	33,3			12,0	329,5	8,1		530,0	HCO3-Mg-Ca
		mg-ekv/l	0,55	0,28		2,36	4,09		0,003	0,76	0,69			0,40	5,40	6,5	1,0	365,0	
14034	09.05.97	mg/l	54,0		0,02	146,2	21,9		0,530	62,0	170,0	8,40	0,110		368,4	7,3		840,0	HCO3-SO4-Ca
		mg-ekv/l	2,35			7,30	1,80		0,024	1,75	3,54	0,14	0,002		6,04	9,1	1,3	621,0	
17020	29.10.97	mg/l	11,7		0,23	92,0	38,3		<0,050	39,0	31,0	5,54	0,014		392,3	8,2		615,0	HCO3-Ca-Mg
		mg-ekv/l	0,51		0,01	4,59	3,15			1,10	0,64	0,09			6,43	7,7	1,6	410,0	
19616	08.01.88	mg/l	22,9			43,5	43,1			18,1	28,8		0,010		341,7			498,1	HCO3-Mg-Ca
		mg-ekv/l	1,00			2,17	3,54			0,51	0,60				5,60	5,7	2,3	336,5	
19627	19.11.87	mg/l	22,9			43,5	43,1			18,1	28,8		0,010		341,7			498,1	HCO3-Mg-Ca
		mg-ekv/l	1,00			2,17	3,54			0,51	0,60				5,60	5,7	1,6	336,5	
19628	01.10.87	mg/l	22,9			43,5	43,1			18,1	28,8		0,010		341,7			498,1	HCO3-Mg-Ca
		mg-ekv/l	1,00			2,17	3,54			0,51	0,60				5,60	5,7	2,3	336,5	
19629	29.09.87	mg/l	52,4			105,6	67,1		0,150	93,6	228,8	4,50	0,090		329,5			881,7	HCO3-SO4-Mg-Ca
		mg-ekv/l	2,28			5,27	5,52		0,008	2,64	4,76	0,07	0,002		5,40	10,8	1,8	807,5	
Mine 4 area																			
15362	28.02.01	mg/l	47,4		0,25	100,0	50,4		0,050	13,8	227,0	0,00	0,005		323,3	7,9		762,2	HCO3-SO4-Ca-Mg
		mg-ekv/l	2,06		0,01	4,99	4,14		0,002	0,39	4,72				5,30	9,1	1,5	742,0	
15484	28.06.01	mg/l	108,1		0,36	120,0	24,0		0,050	12,2	347,0		0,001		347,7	8,4		959,4	SO4-HCO3-Ca-Na+K
		mg-ekv/l	4,70		0,02	5,99	1,97		0,002	0,34	7,22				5,70	8,0	2,3	832,0	
15485	26.06.01	mg/l	78,2		0,67	120,0	69,6		0,090	24,3	406,0		0,003		366,0	8,6		1064,9	SO4-HCO3-Ca-Mg-Na+K
		mg-ekv/l	3,40		0,04	5,99	5,72		0,004	0,69	8,44				6,00	11,7	3,5	892,0	
15486	25.06.01	mg/l	82,8		0,30	144,0	64,2		0,030	29,5	448,0		0,002		359,9	8,4		1128,7	SO4-HCO3-Ca-Mg-Na+K
		mg-ekv/l	3,60		0,02	7,19	5,28		0,001	0,83	9,32				5,90	12,5	1,7	960,0	
15559	05.04.01	mg/l	149,5		0,33	120,0	52,2		0,010	23,4	509,0	0,00	0,002		354,0	8,0		1208,4	SO4-HCO3-Na+K-Ca-Mg
		mg-ekv/l	6,50		0,02	5,99	4,29			0,66	10,59				5,81	10,3	2,2	1050,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
15560	15.05.01	mg/l	156,7		0,29	100,0	64,8		0,910	13,9	515,0	0,00	0,002		372,0	8,4		1223,6	SO4-HCO3-Na+K-Mg-Ca
		mg-ekv/l	6,82		0,02	4,99	5,33		0,041	0,39	10,71				6,10	10,3	2,3	1058,0	
15561	20.03.01	mg/l	18,4		0,09	96,0	55,2		0,350	5,2	223,0	0,00	0,002		167,0	8,2		565,2	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,80			4,79	4,54		0,016	0,15	4,64				2,74	9,3	1,6	700,0	
15563	18.04.01	mg/l	149,5		0,33	120,0	52,2		0,010	23,4	509,0	0,00	0,002		354,0	8,0		1208,4	SO4-HCO3-Na+K-Ca-Mg
		mg-ekv/l	6,50		0,02	5,99	4,29			0,66	10,59				5,81	10,3	2,2	1050,0	
15564	12.03.01	mg/l	57,7		0,33	104,0	48,0		0,020	34,7	205,0	0,00	0,001		329,4	8,0		779,2	HCO3-SO4-Ca-Mg-Na+K
		mg-ekv/l	2,51		0,02	5,19	3,95		0,001	0,98	4,26				5,40	9,1	0,8	732,0	
15618	20.11.01	mg/l	31,7		0,16	126,0	44,4		0,330	32,5	301,0		0,003		256,2	8,2		792,3	SO4-HCO3-Ca-Mg
		mg-ekv/l	1,38		0,01	6,29	3,65		0,015	0,92	6,26				4,20	9,9	2,1	780,0	
15619	03.12.01	mg/l	39,1		0,29	66,0	31,2		0,810	14,5	120,0	0,01	0,001		268,4	8,3		540,3	HCO3-SO4-Ca-Mg-Na+K
		mg-ekv/l	1,70		0,02	3,29	2,56		0,036	0,41	2,50				4,40	5,8	2,5	430,0	
15672	09.05.01	mg/l	47,4		0,42	100,0	50,4		0,670	33,0	377,0	0,00	0,002		323,3	8,4		932,2	SO4-HCO3-Ca-Mg
		mg-ekv/l	2,06		0,02	4,99	4,14		0,030	0,93	7,84				5,30	9,1	2,4	1000,0	
Kiviõli and Kohtla mines area																			
3659	09.06.86	mg/l	19,3	8,0		82,6	50,1		0,100	23,4	191,8		0,016	18,0	274,6	8,4	13,2	670,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,84	0,20		4,12	4,12		0,004	0,66	3,99			0,60	4,50	8,2	0,8	570,5	
4247	03.04.92	mg/l	19,3			10,0	45,6		0,330	15,3	240,0	0,01	0,009		335,6	7,0		670,0	HCO3-SO4-Mg
		mg-ekv/l	0,84			0,50	3,75		0,015	0,43	4,99				5,50	4,3	2,4	782,0	
13518	03.10.90	mg/l	18,1	10,7		57,3	38,6		0,160	11,0	29,6			6,0	311,2	8,1	2,2	490,0	HCO3-Mg-Ca
		mg-ekv/l	0,79	0,27		2,86	3,17		0,009	0,31	0,62			0,20	5,10	6,0	1,5	547,0	
13545	11.08.90	mg/l	45,9	11,0	0,12	135,3	32,2		0,120	27,3	79,0		0,013	6,0	274,6	8,0	11,0	620,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	2,00	0,28	0,01	6,75	2,65		0,006	0,77	1,64			0,20	4,50	9,4	2,6	618,0	
15903	20.12.01	mg/l	13,8		0,14	40,0	16,8		0,140	31,3	25,1	0,02	0,001		329,0	8,4		456,3	HCO3-Ca-Mg
		mg-ekv/l	0,60		0,01	2,00	1,38		0,006	0,88	0,52				5,40	3,4	1,5	304,0	
19448	19.07.85	mg/l	65,8	4,6		12,8	7,8			25,2	<0,0				170,9			287,0	HCO3-Na
		mg-ekv/l	2,86	0,12		0,64	0,64			0,71					2,80	1,3	0,8	197,5	
19449	02.11.85	mg/l	30,0	5,0		12,4	15,6			10,6	8,6				189,2			271,0	HCO3-Na-Mg
		mg-ekv/l	1,30	0,13		0,62	1,28			0,30	0,18				3,10	1,9	1,3	186,0	
Aidu open-cast mine area																			
2603	1970	mg/l	75,2			34,7	18,7			37,6	56,8				262,4			490,0	HCO3-Na+K-Ca-Mg
		mg-ekv/l	3,27			1,73	1,54			1,06	1,18				4,30	3,3		412,0	
3717	22.04.86	mg/l	50,0	12,0	0,30	112,0	47,6			114,5	95,3		0,042	12,0	360,0	7,7	6,6	820,0	HCO3-Cl-Ca-Mg
		mg-ekv/l	2,18	0,31	0,02	5,59	3,91			3,23	1,98		0,001	0,40	5,90	9,5	6,6	650,5	
3718	08.04.86	mg/l	13,1	6,5	0,10	151,5	51,7			29,1	286,0		0,018	6,0	317,3	7,3	8,8	870,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	0,57	0,17	0,01	7,56	4,25			0,82	5,95			0,20	5,20	11,8	3,5	747,0	
4122	09.12.92	mg/l	6,9			120,0	30,4		0,573	24,0	111,8				317,2	7,5		610,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,30			5,99	2,50		0,026	0,68	2,33				5,20	8,5	1,6	726,0	
4265	26.07.91	mg/l	8,8	7,2		124,5	29,5		0,090	42,2	175,7	6,90	0,010		299,0	7,7	6,6	700,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,38	0,18		6,21	2,42		0,004	1,19	3,65	0,11			4,90	8,6	4,2	703,2	
13522	25.05.90	mg/l	48,9	16,5	0,08	128,3	359,5		0,050	98,9	273,2		0,028	6,0	323,4	7,7	8,8	1260,0	SO4-HCO3-Mg
		mg-ekv/l	2,13	0,42		6,40	29,55		0,003	2,79	5,68		0,001	0,20	5,30	36,0	2,5	961,0	
13600	21.06.89	mg/l	110,0	7,5		127,5	29,3		0,020	35,1	168,3	0,20			3111,2	7,8	8,8	3600,0	HCO3-Ca-Na
		mg-ekv/l	4,79	0,19		6,36	2,41		0,001	0,99	3,50				51,02	8,8	1,5	565,0	
13609	17.02.89	mg/l	16,0	7,0		117,4	23,6		0,080	44,3	106,6	9,30			341,7	7,6		670,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,70	0,18		5,86	1,94		0,004	1,25	2,22	0,15			5,60	7,8	2,7	559,0	
Estonia, Viru and Ahtme mines area																			
2651	05.04.63	mg/l	22,1		0,10	74,1	21,9			10,3	46,4				317,3	7,6		490,0	HCO3-Ca-Mg
		mg-ekv/l	0,96		0,01	3,70	1,80			0,29	0,97				5,20	5,5			
2653	23.09.67	mg/l	24,1		0,10	46,1	36,4			15,0	20,0		0,010		335,6	8,0		480,0	HCO3-Mg-Ca
		mg-ekv/l	1,05		0,01	2,30	2,99			0,42	0,42				5,50	5,3	2,2		
2983	04.07.65	mg/l	46,4			55,1	24,9			17,0	4,0	2,30		42,0	294,0	7,5		490,0	HCO3-Ca-Na+K-Mg
		mg-ekv/l	2,02			2,75	2,05			0,48	0,08	0,04		1,40	4,82	4,8	1,7	345,5	
2996		mg/l	67,4		0,10	30,3	27,1			27,7	12,0			30,0	7,6	7,6		200,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
	03.09.65	mg-ekv/l	2,93		0,01	1,51	2,23			0,78	0,25			1,00	0,12	3,7	2,2		Cl-Na+K-Mg-Ca
2998	24.10.66	mg/l	3,1	13,0	0,10	50,1	55,0		0,300	5,0	4,0	4,80	0,600	14,4	424,7	7,5		580,0	HCO3-Mg-Ca
		mg-ekv/l	0,13	0,33	0,01	2,50	4,52		0,013	0,14	0,08	0,08	0,013	0,48	6,97	7,0	2,5	377,5	
3007	15.09.66	mg/l	30,0	5,8	0,10	22,4	10,5			8,5	4,0				208,7	7,4		290,0	HCO3-Na-Ca-Mg
		mg-ekv/l	1,31	0,15	0,01	1,12	0,86			0,24	0,08				3,42	2,0	1,4	166,5	
3015	11.11.70	mg/l	38,4		0,10	41,7	43,9			6,7	2,0	2,00		30,0	372,2	7,4		550,0	HCO3-Mg-Ca-Na+K
		mg-ekv/l	1,67		0,01	2,08	3,61			0,19	0,04	0,03		1,00	6,10	5,7			
3295	18.10.69	mg/l	50,7			24,2	18,5		0,300	7,1				24,0	231,9	7,4		370,0	HCO3-Na+K-Mg-Ca
		mg-ekv/l	2,21			1,21	1,52		0,013	0,20				0,80	3,80	2,7	0,6	251,0	
3295	24.10.69	mg/l	44,0			25,2	22,1		0,300	7,1				6,0	262,4	7,4		380,0	HCO3-Na+K-Mg-Ca
		mg-ekv/l	1,91			1,26	1,82		0,013	0,20				0,20	4,30	3,1	0,6	235,5	
3723	16.12.85	mg/l	31,2			43,5	44,4			11,3	4,0			36,0	353,9	8,4		530,0	HCO3-Mg-Ca
		mg-ekv/l	1,36			2,17	3,65			0,32	0,08			1,20	5,80	5,8	3,8	343,0	
4084	27.05.88	mg/l	10,0	12,0	0,20	38,0	45,6			12,1	4,0		0,004	24,0	353,9	8,0		500,0	HCO3-Mg-Ca
		mg-ekv/l	0,43	0,31	0,01	1,90	3,75			0,34	0,08			0,80	5,80	5,7	4,2	326,0	
12282	07.03.91	mg/l	5,0	10,0	0,64	74,2	41,3		0,110	23,4	77,0		0,035	6,0	347,3	7,7	17,6	590,0	HCO3-Ca-Mg
		mg-ekv/l	0,22	0,26	0,04	3,70	3,39		0,006	0,66	1,60		0,001	0,20	5,70	7,1	1,4	592,0	
12284	14.12.90	mg/l	17,9	8,0		63,1	35,9			25,9	83,1	0,70			286,9	8,2	4,4	530,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,78	0,20		3,15	2,95			0,73	1,73	0,01			4,71	6,1	2,9	534,0	
12285	14.09.90	mg/l	18,1	11,4		57,3	50,6		0,050	14,9	18,0		0,543		402,7	7,9	17,6	580,0	HCO3-Mg-Ca
		mg-ekv/l	0,79	0,29		2,86	4,16		0,003	0,42	0,37		0,012		6,60	7,0	0,5	581,0	
12286	28.03.90	mg/l	21,7	11,7		489,0	41,1		0,050	17,7	18,0		0,291	24,0	341,7	7,9		970,0	HCO3-Ca
		mg-ekv/l	0,94	0,30		24,40	3,38		0,003	0,50	0,37		0,006	0,80	5,60	27,8	1,0	534,0	
12287	03.04.90	mg/l	18,2	11,7		44,9	41,1		0,180	12,4	37,4	0,70	0,219	24,0	292,7	8,0	11,0	490,0	HCO3-Mg-Ca
		mg-ekv/l	0,79	0,30		2,24	3,38		0,010	0,35	0,78	0,01	0,005	0,80	4,80	5,6	0,8	492,0	
12288	04.03.90	mg/l	31,7	9,5		35,1	23,6			12,4	21,4	4,40		12,0	268,5	7,9	2,2	430,0	HCO3-Mg-Ca-Na
		mg/l	31,7	9,5		35,1	23,6			12,4	21,4	4,40		12,0	268,5	7,9	2,2	430,0	
12288	04.03.90	mg-ekv/l	1,38	0,24		1,75	1,94			0,35	0,45	0,07		0,40	4,40	3,7		427,0	
		mg-ekv/l	1,38	0,24		1,75	1,94			0,35	0,45	0,07		0,40	4,40	3,7		427,0	
12288	26.03.01	mg/l	39,0	10,0	<0,05	34,1	28,9	0,330	0,330	11,0	15,6	<0,40	0,003	<6,0	341,7	7,6	13,2	488,1	HCO3-Mg-Ca-Na
		mg/l	39,0	10,0	<0,05	34,1	28,9	0,330	0,330	11,0	15,6	<0,40	0,003	<6,0	341,7	7,6	13,2	488,1	
12288	26.03.01	mg-ekv/l	1,70	0,26		1,70	2,38	0,012	0,015	0,31	0,32		0,000		5,60	4,1	0,3	342,5	
		mg-ekv/l	1,70	0,26		1,70	2,38	0,012	0,015	0,31	0,32				5,60	4,1	0,3	342,5	
12289	04.04.90	mg/l	28,3	9,3		38,5	34,8			19,2	22,6		0,028	18,0	286,7	8,0	8,8	470,0	HCO3-Mg-Ca
		mg-ekv/l	1,23	0,24		1,92	2,86			0,54	0,47		0,001	0,60	4,70	4,8		469,0	
12291	03.05.89	mg/l	15,0	11,7		24,7	43,6			16,7	35,0			18,0	268,5	8,7		440,0	HCO3-Mg-Ca
		mg-ekv/l	0,65	0,30		1,23	3,58			0,47	0,73			0,60	4,40	4,8	0,6	306,0	
12292	19.05.89	mg/l	27,9	10,7		41,7	38,9		0,030	23,4	42,8			12,0	282,9	7,8	30,8	490,0	HCO3-Mg-Ca
		mg-ekv/l	1,21	0,27		2,08	3,20		0,002	0,66	0,89			0,40	4,64	5,3	2,4	353,0	
12293	25.05.89	mg/l	0,6	0,3		3,1	4,9			0,4	3,6				4,8	8,4		25,0	SO4-HCO3-Mg-Ca
		mg-ekv/l	0,02	0,01		0,15	0,40			0,01	0,08				0,08	0,6	0,9	520,0	
12294	25.05.89	mg/l	27,1	10,7		58,9	28,3		0,060	23,4	66,5		0,020	12,0	234,9	8,0	2,2	470,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,18	0,27		2,94	2,33		0,003	0,66	1,38			0,40	3,85	5,3	2,3	520,0	
12295	24.05.89	mg/l	26,7	11,2		38,1	36,7			13,5	43,2		0,024	12,0	317,3	8,3		510,0	HCO3-Mg-Ca
		mg-ekv/l	1,16	0,29		1,90	3,02			0,38	0,90		0,001	0,40	5,20	4,9	1,1	373,0	
12297	18.10.95	mg/l	0,1		0,08	84,0	33,6		0,240	14,6	25,1		0,020		222,6	8,2		325,5	HCO3-Ca-Mg
		mg-ekv/l				4,19	2,76		0,011	0,41	0,52				3,65	7,0	1,9	460,0	
15732	03.08.01	mg/l	40,7		0,65	72,0	28,8		0,480	5,2	123,0	0,44	0,004		305,0	8,3		576,3	HCO3-SO4-Ca-Mg-Na+K
		mg-ekv/l	1,77		0,04	3,59	2,37		0,022	0,15	2,56	0,01			5,00	6,0	2,4	454,0	
Area located to North from oil shale mines																			
2366	24.12.74	mg/l	36,8			66,1	29,2		0,100	32,0	35,0				347,8			547,0	HCO3-Ca-Mg-Na+K
		mg-ekv/l	1,60			3,30	2,40		0,004	0,90	0,73				5,70	5,7	3,4	588,0	
2366	27.12.75	mg/l	37,5		0,10	66,1	29,2		0,100	32,0	35,0				347,8	8,0		550,0	HCO3-Ca-Mg
		mg-ekv/l	0,96		0,01	3,30	2,40		0,004	0,90	0,73				5,70	5,7	3,4		

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
2650	09.07.76	mg/l	10,8		0,26	95,1	30,4		0,300	30,0	90,0				305,1			560,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,47		0,01	4,75	2,50		0,013	0,85	1,87				5,00	7,3	2,4	468,0	
3738	26.05.88	mg/l	13,6	11,0	0,08	37,1	31,0			22,7	26,3			12,0	256,3	8,1		420,0	HCO3-Mg-Ca
		mg-ekv/l	0,59	0,28		1,85	2,55			0,64	0,55			0,40	4,20	4,4	1,6	284,0	
4010	28.06.73	mg/l	45,7	11,4	0,10	29,5	27,4			14,2	6,0			24,0	286,8	8,3		450,0	HCO3-Mg-Na-Ca
		mg-ekv/l	1,99	0,29	0,01	1,47	2,25			0,40	0,12			0,80	4,70	3,7	1,4	317,5	
4030	05.09.87	mg/l	15,2	3,0		176,8	20,3	1,200	1,620	39,7	241,9	0,90			329,5	7,4	4,4	840,0	HCO3-SO4-Ca
		mg-ekv/l	0,66	0,08		8,82	1,67	0,043	0,073	1,12	5,03	0,01			5,40	10,5	5,8	741,0	
4064	19.09.87	mg/l	2,0	1,0	2,00	92,4	16,7	0,800	0,800	18,1	53,9	1,40			280,7	7,3	26,4	480,0	HCO3-Ca-Mg
		mg-ekv/l	0,09	0,03	0,11	4,61	1,37	0,029	0,036	0,51	1,12	0,02			4,60	6,0	1,6	361,0	
4065	11.09.87	mg/l	2,0	0,0		88,4	7,2	0,600	0,600	7,1	84,8	1,30			207,5	7,9	4,4	410,0	HCO3-SO4-Ca
		mg-ekv/l	0,09	0,00		4,41	0,59	0,021	0,027	0,20	1,76	0,02			3,40	5,0	14,4	343,5	
4123	18.12.92	mg/l	11,5		0,38	130,3	54,7		0,933	89,4	99,8	2,76	0,090		378,2	7,5		770,0	HCO3-Cl-Ca-Mg
		mg-ekv/l	0,50		0,02	6,50	4,50		0,042	2,52	2,08	0,04	0,002		6,20	11,0	1,8	910,0	
4159	26.08.91	mg/l	15,0	11,6		44,1	46,2			17,7	12,0	2,10		12,0	341,7	8,0	4,4	510,0	HCO3-Mg-Ca
		mg-ekv/l	0,65	0,30		2,20	3,80			0,50	0,25	0,03		0,40	5,60	6,0	0,7	510,4	
4227	19.07.91	mg/l	13,3			107,0	20,1		0,090	10,6	108,6		0,368		311,2	7,8	6,6	580,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,58			5,34	1,65		0,004	0,30	2,26		0,008		5,10	7,0	1,0	581,3	
4229	24.07.91	mg/l	9,3		0,42	126,5	17,7		0,090	17,7	157,2	1,50			92,9	7,6	11,0	430,0	SO4-HCO3-Ca
		mg-ekv/l	0,40		0,02	6,31	1,45		0,004	0,50	3,27	0,02			1,52	7,8	1,6	632,5	
4231	18.09.92	mg/l	5,8		0,04	104,2	31,6		0,380	40,8	73,3	5,10	0,040		372,0	7,8		630,0	HCO3-Ca-Mg
		mg-ekv/l	0,25			5,20	2,60		0,017	1,15	1,52	0,08	0,001		6,10	7,8	4,8	818,0	
4233	31.03.92	mg/l	8,3			130,0	6,0		0,044	47,9	67,5		0,009		183,0	7,3		440,0	HCO3-SO4-Cl-Ca
		mg-ekv/l	0,36			6,49	0,49		0,002	1,35	1,40				3,00	7,0	2,2	230,0	
4234	01.07.91	mg/l	60,0	8,3		35,1	28,3			17,7	35,0				347,8			530,0	HCO3-Na-Mg-Ca
		mg-ekv/l	2,61	0,21		1,75	2,33			0,50	0,73				5,70	4,1		381,5	
4234	01.07.93	mg/l	60,0	8,3		35,1	28,3			17,7	35,0				347,8			530,0	HCO3-Na-Mg-Ca
		mg-ekv/l	2,61	0,21		1,75	2,33			0,50	0,73				5,70	4,1		381,0	
4235	17.12.91	mg/l			0,39	102,0	48,0		0,230	13,5	28,4	0,04	0,011		214,0	7,5		410,0	HCO3-Ca-Mg
		mg-ekv/l	0,00		0,02	5,09	3,95		0,010	0,38	0,59				3,51	9,0		530,0	
4265	26.07.91	mg/l	8,8	7,2		124,5	29,5		0,090	42,2	175,7	6,90	0,010		299,0	7,7	6,6	700,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,38	0,18		6,21	2,42		0,004	1,19	3,65	0,11			4,90	8,6	4,2	703,2	
9002	17.12.93	mg/l	0,2		0,47	142,0	28,8			23,0	51,1		0,009		183,0	7,5		430,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,01		0,03	7,09	2,37			0,65	1,06				3,00	9,5		634,0	
9003	16.12.91	mg/l	0,2		0,29	130,0	24,0			76,6	46,9	0,15	0,019		137,0	7,7		420,0	HCO3-Cl-Ca-Mg
		mg-ekv/l	0,01		0,02	6,49	1,97			2,16	0,98				2,25	8,5		630,0	
9004	01.04.92	mg/l	7,6		2,70	104,0	12,0		0,056	42,6	62,0	1,24	0,049		189,1	7,3		420,0	HCO3-SO4-Cl-Ca
		mg-ekv/l	0,33		0,15	5,19	0,99		0,003	1,20	1,29	0,02	0,001		3,10	6,2	1,9	390,0	
13458	21.02.91	mg/l	13,5	11,4		41,1	34,6		0,070	19,9	24,3			18,0	280,7			440,0	HCO3-Mg-Ca
		mg-ekv/l	0,59	0,29		2,05	2,84		0,004	0,56	0,51			0,60	4,60	4,9		451,0	
13496	15.05.96	mg/l	20,2	31,2	0,13	100,2	28,0		0,190	48,3	84,0	1,00	<0,001		359,9	7,7		670,0	HCO3-Ca-Mg
		mg-ekv/l	0,88	0,80	0,01	5,00	2,30		0,009	1,36	1,75	0,02			5,90	7,3	1,0	526,0	
13517	12.09.90	mg/l	26,0	3,3		109,4	28,5		0,050	59,2	93,4		0,584		329,5	7,4	24,2	660,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,13	0,08		5,46	2,34		0,003	1,67	1,94		0,013		5,40	7,8	2,8	659,0	
13543	03.10.90	mg/l	7,2	8,0		55,3	29,7		0,090	11,0	29,6			6,0	211,2	8,1	2,2	360,0	HCO3-Ca-Mg
		mg-ekv/l	0,31	0,20		2,76	2,44		0,005	0,31	0,62			0,20	3,46	5,2	1,5	463,0	
13547	27.04.90	mg/l	48,9	16,5	0,08	128,3	59,5		0,050	98,9	273,2		0,028	6,0	323,4	7,7	8,8	960,0	SO4-HCO3-Ca-Mg
		mg-ekv/l	2,13	0,42		6,40	4,89		0,003	2,79	5,68		0,001	0,20	5,30	11,3	2,5	961,0	
13564	04.12.95	mg/l	23,0		<0,01	100,2	20,7		0,502	37,4	81,7	0,40	0,007		298,9	7,9		560,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,00			5,00	1,70		0,022	1,05	1,70	0,01			4,90	6,7	1,4	450,0	
13567	16.12.94	mg/l	6,9	42,9	0,35	130,3	0,0		0,156	28,6	56,4	0,87	0,018		359,9	8,2			-
		mg-ekv/l	0,30	1,10	0,02	6,50			0,007	0,81	1,17	0,01			5,90	6,5	2,4	479,0	
13568	15.12.94	mg/l	8,1	35,1	0,23	92,2	14,6		0,200	32,7	38,0	1,18	0,040		329,4	7,9		550,0	HCO3-Ca
		mg-ekv/l	0,35	0,90	0,01	4,60	1,20		0,009	0,92	0,79	0,02	0,001		5,40	5,8	4,6	422,0	
13579		mg/l	43,8			133,7	57,2			112,0	223,9				355,6	7,8	6,6	930,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
	12.03.89	mg-ekv/l	1,91			6,67	4,70			3,16	4,66				5,83	11,4	1,4	785,0	HCO3-SO4-Cl-Ca-Mg
13590	03.05.89	mg/l	21,3	3,7		60,7	24,3			30,1	58,0	21,30		6,0	238,0	8,3	2,2	470,0	HCO3-Ca-Mg
		mg-ekv/l	0,93	0,09		3,03	2,00			0,85	1,21	0,34		0,20	3,90	5,0	0,7	397,0	
13591	27.04.89	mg/l	4,3	8,3		68,9	31,1			31,9	51,0	40,70		6,0	244,1	8,3	2,2	490,0	HCO3-Ca-Mg
		mg-ekv/l	0,19	0,21		3,44	2,56			0,90	1,06	0,66		0,20	4,00	6,0	1,1	373,0	
13599	06.05.89	mg/l	22,5	12,5		25,5	37,6			14,9	26,7			36,0	244,1	8,4		430,0	HCO3-Mg-Ca
		mg-ekv/l	0,98	0,32		1,27	3,09			0,42	0,56			1,20	4,00	4,4	1,4	307,0	
13610	22.02.89	mg/l	8,0	5,7		116,4	32,8			44,3	165,9	5,10			244,1	7,6		630,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,35	0,15		5,81	2,70			1,25	3,45	0,08			4,00	8,5	2,6	503,5	
14408	18.02.98	mg/l	72,1		0,02	56,0	5,2		0,550	43,0	53,0	0,04	0,011		248,3	8,7		483,0	HCO3-Na+K-Ca
		mg-ekv/l	3,13			2,79	0,43		0,025	1,21	1,10				4,07	3,2	1,8	370,0	
14442	03.04.98	mg/l	12,5		0,59	88,0	14,8		0,110	15,0	55,0	3,57	0,020		278,8	7,3		480,0	HCO3-Ca
		mg-ekv/l	0,55		0,03	4,39	1,22		0,005	0,42	1,14	0,06			4,57	5,6	4,1	400,0	
14761	15.12.98	mg/l	15,6		0,06	94,8	26,5		0,480	20,0	53,0	9,17	0,034		353,8	7,6		578,0	HCO3-Ca-Mg
		mg-ekv/l	0,68			4,73	2,18		0,022	0,56	1,10	0,15	0,001		5,80	6,9	1,2	450,0	
15563	18.04.01	mg/l	149,5		0,33	120,0	52,2		0,010	23,4	509,0	0,00	0,002		354,0	8,0		1208,4	SO4-HCO3-Na+K-Ca-Mg
		mg-ekv/l	6,50		0,02	5,99	4,29			0,66	10,59				5,81	10,3	2,2	1050,0	
15564	12.03.01	mg/l	57,7		0,33	104,0	48,0		0,020	34,7	205,0	0,00	0,001		329,4	8,0		779,2	HCO3-SO4-Ca-Mg-Na+K
		mg-ekv/l	2,51		0,02	5,19	3,95		0,001	0,98	4,26				5,40	9,1	0,8	732,0	
15566	23.03.01	mg/l	0,1		0,07	64,0	45,6		0,280	8,7	35,4	0,00	0,002		186,0	8,3		273,1	HCO3-Mg-Ca
		mg-ekv/l				3,19	3,75		0,013	0,25	0,74				3,05	6,9	1,3	400,0	
15850	17.07.01	mg/l	86,8		2,00	166,0	68,9		0,130	293,4	160,0	1,95	0,000		378,2	7,9		1157,3	Cl-HCO3-Ca-Mg-Na+K
		mg-ekv/l	3,77		0,11	8,28	5,66		0,006	8,27	3,33	0,03			6,20	13,9	5,9	1219,5	
16018	13.11.01	mg/l	1,3		0,20	90,2	20,6		0,510	8,4	14,0	3,10	0,000		347,7	8,1		486,0	HCO3-Ca-Mg
		mg-ekv/l	0,06		0,01	4,50	1,69		0,023	0,24	0,29	0,05			5,70	6,2	1,4	364,0	
17012	16.07.97	mg/l	42,9			145,0	45,6		0,075	127,0	148,0	0,09	0,002		378,0	7,7		887,0	HCO3-Cl-SO4-Ca-Mg
		mg-ekv/l	1,87			7,24	3,75		0,003	3,58	3,08				6,20	11,0	2,8	710,0	
19540	13.06.92	mg/l	219,0	1117,0	1,28	0,0	3,0			400,0	87,5	0,05		576,0	372,1	12,5			-
		mg-ekv/l	9,53	28,60	0,07		0,25			11,28	1,82			19,18	6,10	0,3		2204,0	
19542	23.04.92	mg/l	173,7	164,1	3,08	226,0	8,5	0,017	0,327	414,8	194,4	0,18	0,001	3,0	396,6	8,3		1584,7	Cl-HCO3-Ca-Na
		mg-ekv/l	7,56	4,20	0,17	11,28	0,70	0,001	0,018	11,70	4,04			0,10	6,50	12,0		1100,0	
19544	12.04.92	mg/l	6,9			114,0	35,2	0,083	0,193	78,0	81,7	3,03			317,3	7,9		636,3	HCO3-Cl-Ca-Mg
		mg-ekv/l	0,30			5,69	2,89	0,003	0,009	2,20	1,70	0,05			5,20	8,6		686,0	
19548	14.03.92	mg/l	57,5	101,6	1,55	130,5	48,6	0,200	1,530	146,0	192,0			0,2	451,4	8,3		1130,9	HCO3-SO4-Cl-Ca-Mg
		mg-ekv/l	2,50	2,60	0,09	6,51	4,00	0,007	0,078	4,12	3,99			0,01	7,40	10,5		631,0	
19550	06.02.92	mg/l	7,6	191,4	0,91	196,3	37,6	0,190	0,480	95,5	135,0	0,06	0,009		457,6	7,7		1122,5	HCO3-SO4-Cl-Ca-K
		mg-ekv/l	0,33	4,90	0,05	9,80	3,09	0,007	0,022	2,69	2,81				7,50	12,9		505,0	
19552	02.03.92	mg/l	11,5	62,5	0,52	170,3	31,6	0,080	0,110	52,1	51,5	0,01	0,004		524,7	7,9		904,8	HCO3-Ca
		mg-ekv/l	0,50	1,60	0,03	8,50	2,60	0,003	0,005	1,47	1,07				8,61	11,1		476,0	
19556	20.06.92	mg/l	25,3	50,7	0,10	100,0	60,0	0,017	0,270	45,2	250,0				359,9	7,8		891,5	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,10	1,30	0,01	4,99	4,93	0,001	0,015	1,27	5,20				5,90	9,9		777,0	
19558	26.06.92	mg/l	0,1		0,04	136,0	64,8	0,028	0,600	35,7	262,0				341,6	7,5		838,6	HCO3-SO4-Ca-Mg
		mg-ekv/l				6,79	5,33	0,001	0,032	1,01	5,45				5,60	12,1		680,0	
19560	30.06.92	mg/l	6,9	93,8	0,08	36,1	20,7		0,330	20,6	73,6				250,0	7,9		502,1	HCO3-SO4-K-Ca-Mg
		mg-ekv/l	0,30	2,40		1,80	1,70		0,015	0,58	1,53				4,10	3,5		502,0	
19606	05.02.02	mg/l	27,0	12,0	0,31	88,4	48,9	0,020	0,440	27,0	127,0	0,20	0,010		395,3	8,2		726,6	HCO3-SO4-Ca-Mg
		mg-ekv/l	1,17	0,31	0,02	4,41	4,02	0,001	0,020	0,76	2,64				6,48	8,4	2,3	630,0	
19608	29.01.02	mg/l	6,5	4,5	0,07	114,4	12,6	0,060	0,230	11,0	55,0	3,10	0,010		323,9	7,9		531,3	HCO3-Ca
		mg-ekv/l	0,28	0,12		5,71	1,04	0,002	0,011	0,31	1,14	0,05			5,31	6,8	6,4	440,0	
19610	23.01.02	mg/l	6,5	4,5	0,08	72,7	34,3	0,130	0,320	11,0	45,0	0,29	0,010		338,6	8,0		513,3	HCO3-Ca-Mg
		mg-ekv/l	0,28	0,12		3,63	2,82	0,005	0,015	0,31	0,94				5,55	6,5	2,3	410,0	
19620	13.04.87	mg/l	49,4			69,1	13,7			11,0	6,3				299,0			448,5	HCO3-Ca-Na+K
		mg-ekv/l	2,15			3,45	1,13			0,31	0,13				4,90	4,6	2,1	392,0	
19622	02.07.87	mg/l	18,3			83,0	63,4			21,3	206,2				335,6			727,8	HCO3-SO4-Mg-Ca
		mg-ekv/l	0,80			4,14	5,21			0,60	4,29				5,50	9,3	1,4	590,0	

No of well	Data of sampling	Unit	CATIONS							ANIONS						pH	Free CO_2, mg/l	Mineralization, mg/l	Chemical type of groundwater
			Na^+	K^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Fe üld	Cl^-	SO_4^{2-}	NO_3^-	NO_2^-	CO_3^{--}	HCO_3^-	hardness, mg-ekv/l	COD, mgO_2/l	TDS, mg/l	
19631	23.09.87	mg/l	22,8			184,6	26,4		0,100	28,7	314,8				305,1			882,5	SO4-HCO3-Ca
		mg-ekv/l	0,99			9,21	2,17		0,005	0,81	6,55				5,00	11,4	5,1	801,0	
19632	28.09.87	mg/l	11,3			63,1	8,3		1,980	7,1	16,0				231,9			339,7	HCO3-Ca
		mg-ekv/l	0,49			3,15	0,68		0,106	0,20	0,33				3,80	3,8	5,6	264,0	
19635	06.01.88	mg/l	110,1			27,7	13,1		0,130	72,0	25,1				274,6			522,7	HCO3-Cl-Na+K
		mg-ekv/l	4,79			1,38	1,08		0,007	2,03	0,52				4,50	2,5	0,6	403,5	
Area located to South from oil shale mines																			
2589	15.07.81	mg/l	73,6	5,2	0,15	13,8	9,7			35,5			<0,010		201,4	7,9	6,6	339,9	HCO3-Cl-Na
		mg-ekv/l	3,20	0,13	0,01	0,69	0,80			1,00					3,30	1,5		248,0	
2619	06.07.76	mg/l	60,5		0,26	34,0	24,3		0,200	25,0	30,0	<0,01	<0,001		305,1			480,0	HCO3-Mg-Ca
		mg-ekv/l	2,63		0,01	1,70	2,00		0,009	0,71	0,62				5,00	3,7	2,8	135,0	
3736	31.05.88	mg/l	26,0	10,5	0,40	37,1	33,4			12,1	10,4		0,006	24,0	317,3	8,1		480,0	HCO3-Mg-Ca
		mg-ekv/l	1,13	0,27	0,02	1,85	2,75			0,34	0,22			0,80	5,20	4,6	1,9	320,0	
4022	18.03.71	mg/l	27,5	8,0	0,20	36,9	35,4		0,300	6,7	2,0			18,0	347,8	8,1		480,0	HCO3-Mg-Ca
		mg-ekv/l	1,20	0,20	0,01	1,84	2,91		0,013	0,19	0,04			0,60	5,70	4,8	1,8	343,0	
4042	15.09.87	mg/l	2,0	1,0		58,9	21,4	0,400	0,420	7,1	52,7				231,9	7,8	4,4	380,0	HCO3-SO4-Ca-Mg
		mg-ekv/l	0,09	0,03		2,94	1,76	0,014	0,019	0,20	1,10				3,80	4,7	1,3	266,0	
4119	28.09.92	mg/l	22,7		0,28	40,1	34,0		0,110	26,6	45,1	0,06			372,0	8,0		540,0	HCO3-Mg-Ca
		mg-ekv/l	0,99		0,02	2,00	2,79		0,005	0,75	0,94				6,10	4,8	3,2	625,0	
4169	02.04.92	mg/l	8,3		0,33	16,0	14,4		1,300	19,5	29,5		0,006		287,3	8,2		380,0	HCO3-Mg-Ca
		mg-ekv/l	0,36		0,02	0,80	1,18		0,058	0,55	0,61				4,71	2,0	2,8	350,0	
4170	02.04.92	mg/l	24,0			34,0	12,0		0,080	24,9	23,9	0,17	0,012		137,3	7,9		260,0	HCO3-Ca-Na+K-Mg
		mg-ekv/l	1,04			1,70	0,99		0,004	0,70	0,50				2,25	2,7	1,0	480,0	
4171	01.04.92	mg/l	30,4			22,0	22,8		0,230	25,9	17,8	0,21	0,012		301,1	8,2		420,0	HCO3-Mg-Na+K-Ca
		mg-ekv/l	1,32			1,10	1,87		0,010	0,73	0,37				4,94	3,0	1,2	500,0	
4226	11.11.92	mg/l	9,4		2,00	50,1	18,2		1,900	54,0	17,9		0,009		292,8	7,8		450,0	HCO3-Cl-Ca-Mg
		mg-ekv/l	0,41		0,11	2,50	1,50		0,085	1,52	0,37				4,80	4,0	9,9	518,0	
5742	29.06.70	mg/l	63,7		0,00	74,8	22,1		0,000	41,8	0,0	2,50		6,0	421,0	7,4		631,9	HCO3-Ca-Na+K-Mg
		mg-ekv/l	2,77			3,73	1,82			1,18		0,04		0,20	6,90	5,5	4,5	346,0	
13480	12.08.90	mg/l	53,3	7,3		30,3	24,7			22,0	18,9		0,019	12,0	299,0	7,7	26,4	480,0	HCO3-Na-Mg-Ca
		mg-ekv/l	2,32	0,19		1,51	2,03			0,62	0,39			0,40	4,90	3,5	1,9	490,0	
19082	23.11.98	mg/l	55,7		0,11	32,5	19,8		0,940	12,0	43,0	0,42	0,120		273,3	8,3		445,0	HCO3-Na+K-Mg-Ca
		mg-ekv/l	2,42		0,01	1,62	1,63		0,042	0,34	0,89	0,01	0,003		4,48	3,3	1,8	360,0	
19084	12.11.98	mg/l	73,3		0,02	53,7	29,3		0,340	17,7	85,0	1,20	0,028		366,0	7,1		633,0	HCO3-SO4-Na+K-Ca-Mg
		mg-ekv/l	3,19			2,68	2,41		0,015	0,50	1,77	0,02	0,001		6,00	5,1	1,3	360,0	

Koostas: V.Savva