

The use of chemical data for investigation of the groundwater flow conditions (Lwówek region, Poland)

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Use of chemical data for verification of the groundwater flow conditions (Lwówek region, Poland)

Outline:

- 1. Introduction**
- 2. The study area**
- 3. Geology and hydrogeology**
- 4. Methods**
- 5. Results and discussion**
- 6. Conclusions**





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Introduction

In the regional recharge zone of the Quaternary aquifers distinct groundwater contamination was investigated, reflected mainly by high nitrate concentration.

The indicated contamination was used to support the investigation of groundwater flow pattern.

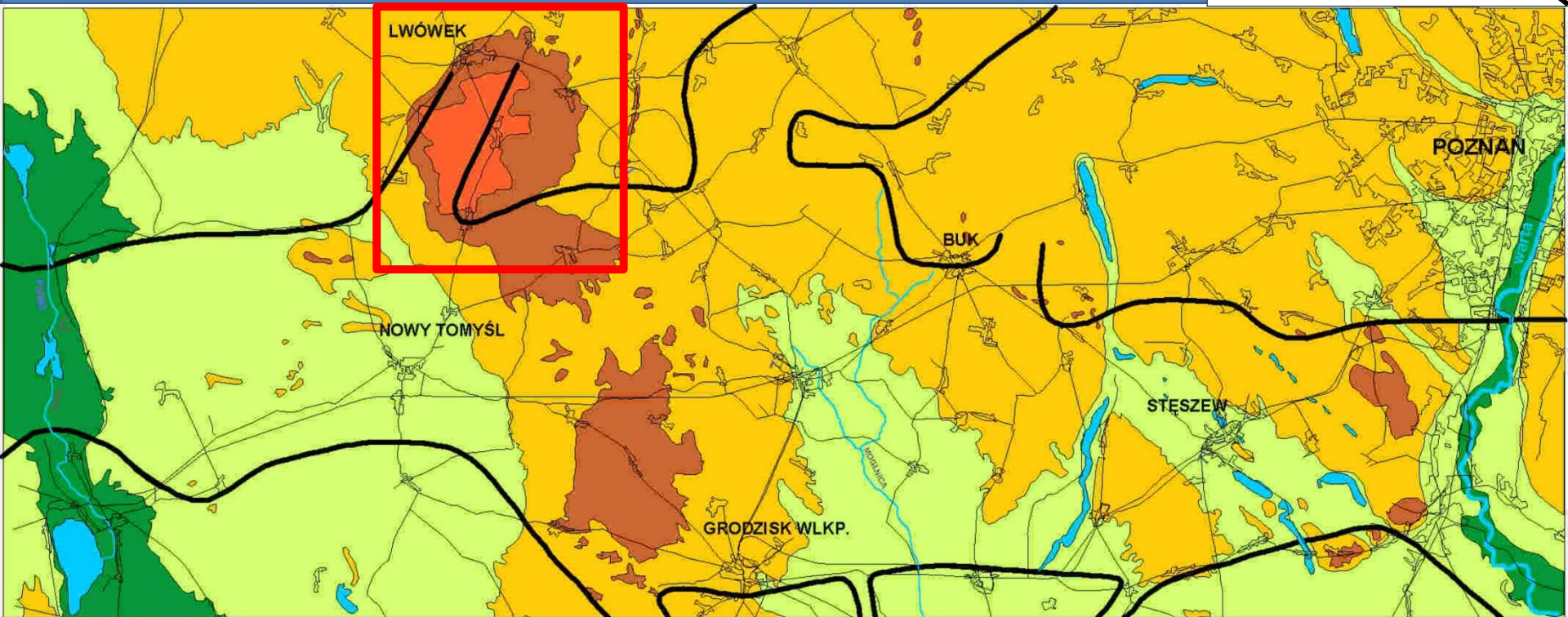
The examination of groundwater chemistry was completed using data from dedicated groundwater monitoring performed in multilevel piezometers and productive wells. The interpretation was supported by isotope analyses.



Outline:

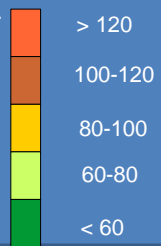
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The study area



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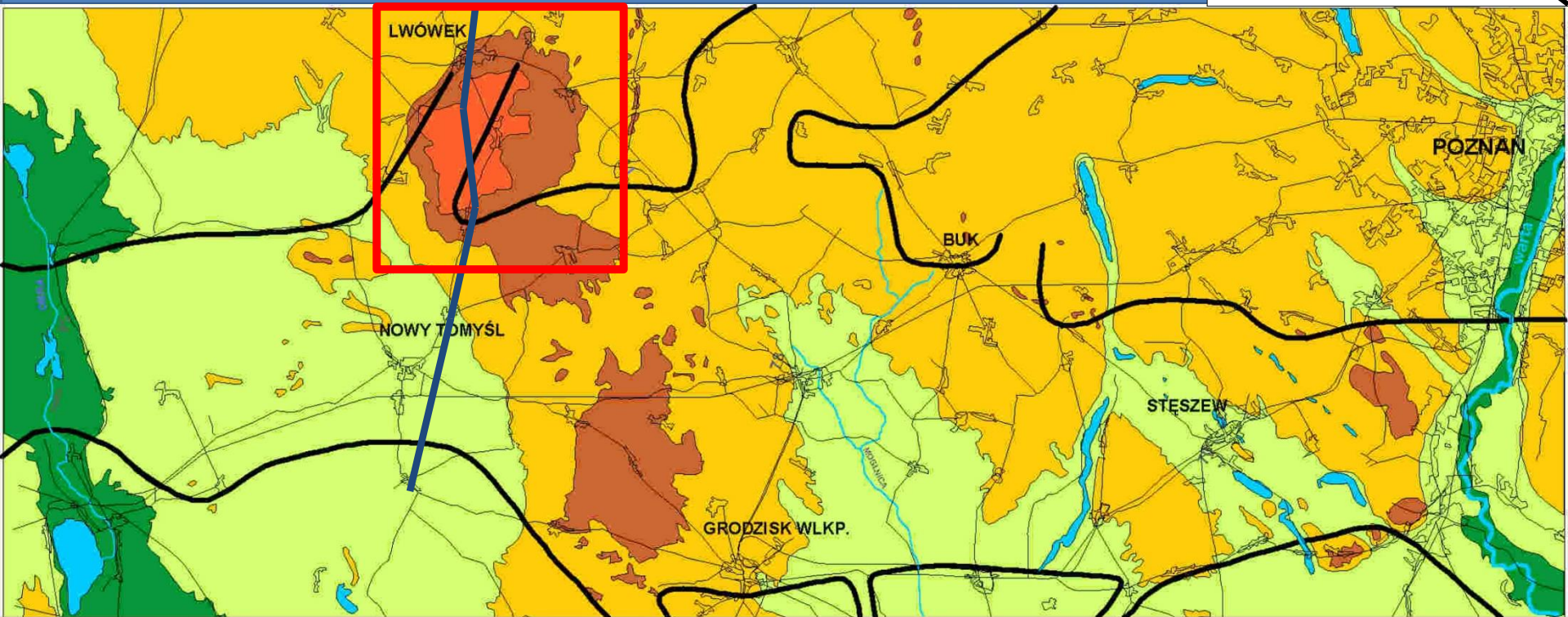




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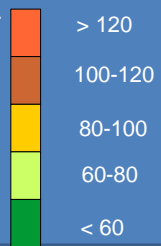
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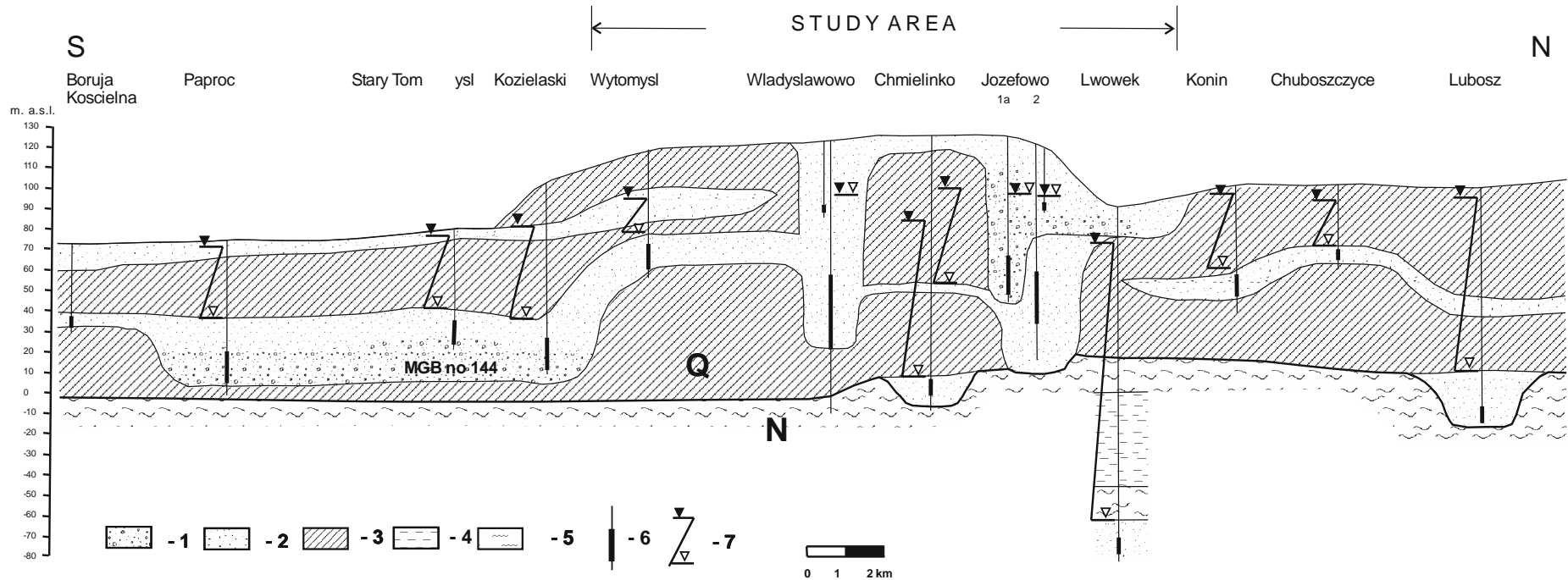
The study area



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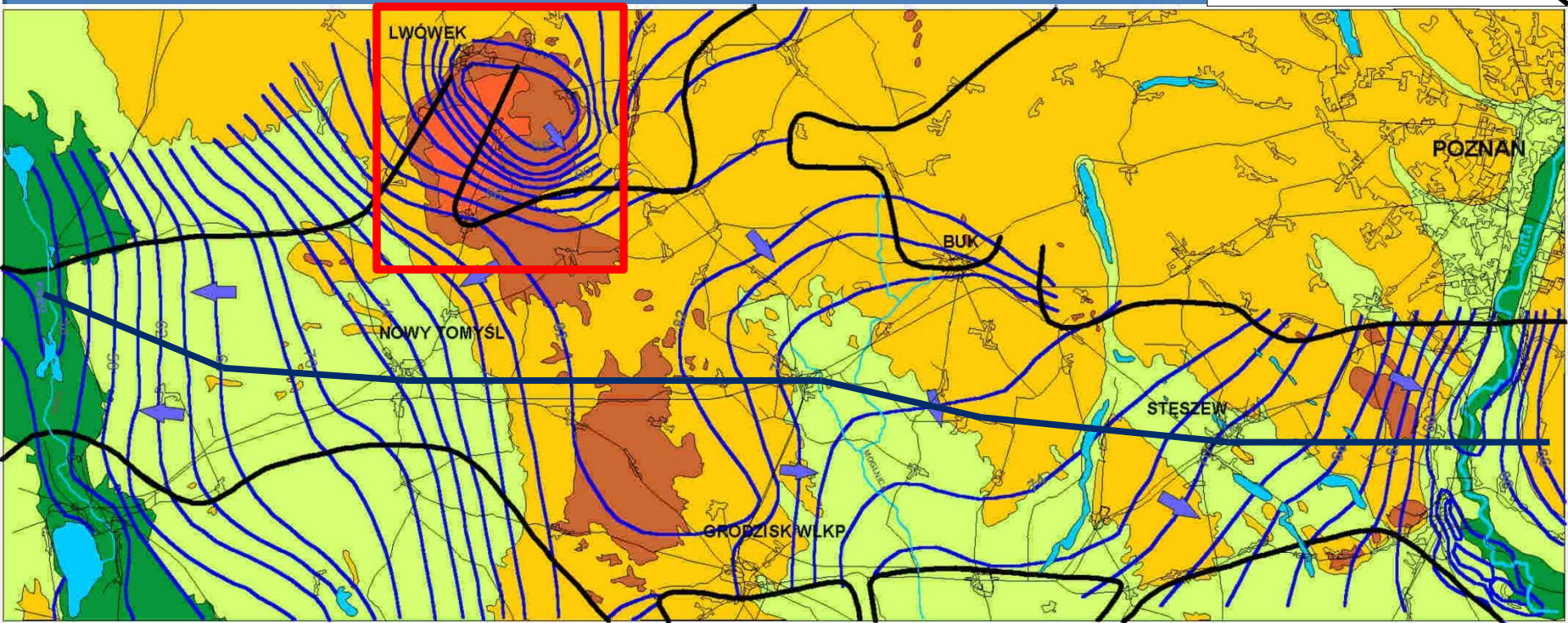
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The hydrogeological cross-section. 1 - Coarse sand and gravel, 2 - medium and fine sand, 3 – till, 4- clay, 5 - brown coal, 6- silt, 7 - the location of the well screen, 8- ground water level, Q- Quaternary, N - Neogene

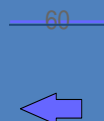
Geology and hydrogeology



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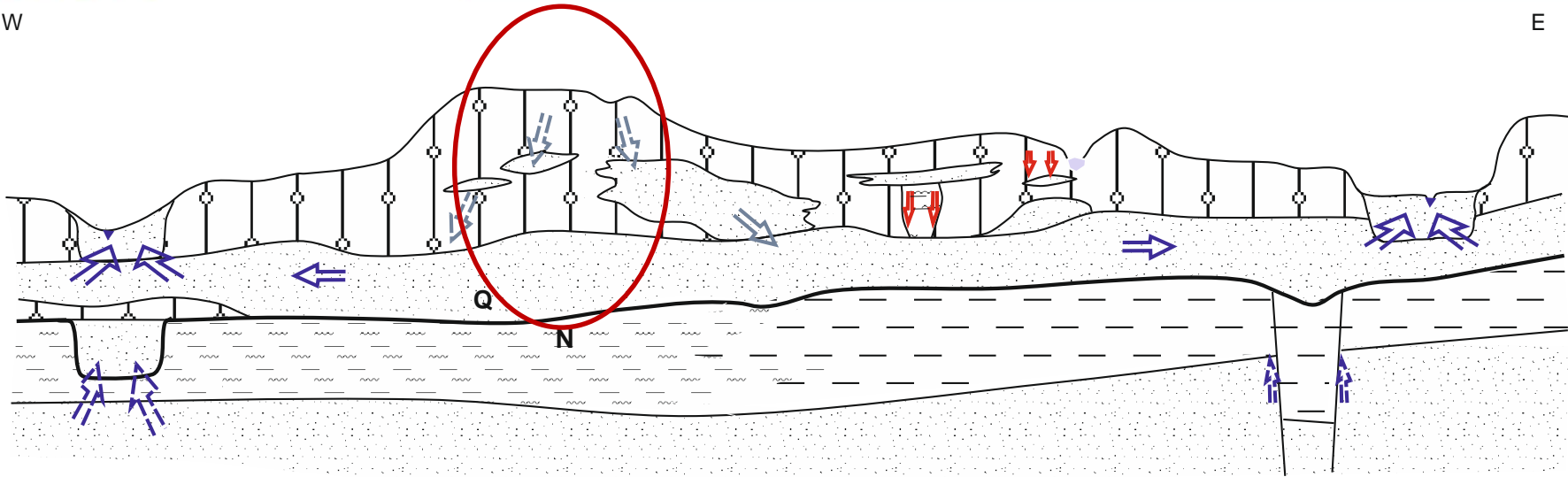
- > 120
- 100-120
- 80-100
- 60-80
- < 60





- The water level contours [m a.s.l.]

- the main groundwater flow direction

The study area



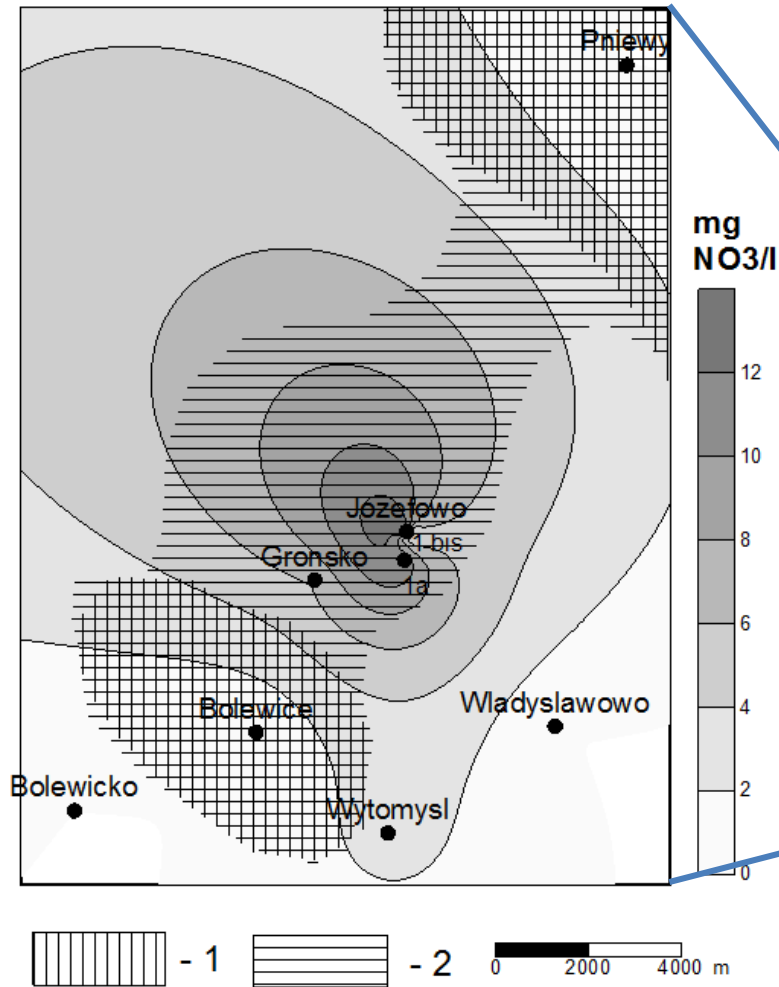
Objaśnienia:

- | | | | |
|---|-----|---|-----|
|  | - 1 |  | - 4 |
|  | - 2 |  | - 5 |
|  | - 3 |  | - 6 |

Schematic cross-section

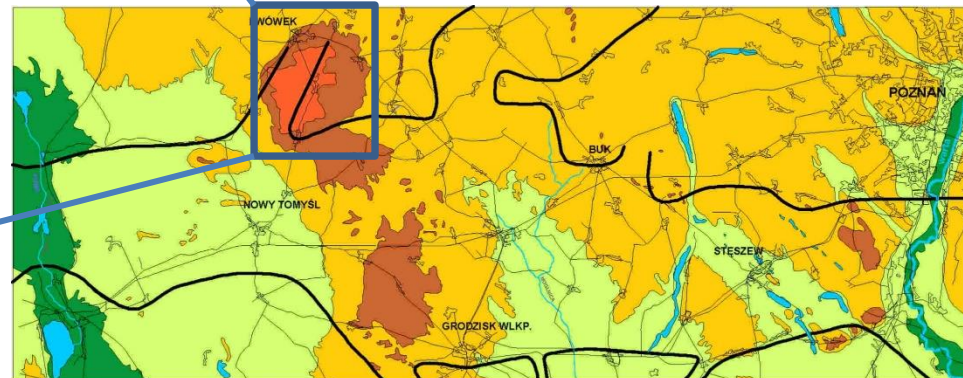
1 and 2 - aquitard (1 - clays, 2 - tills); 3 - aquifers (sands and gravels);
 4 - groundwater flow direction; 5 - groundwater migration through the aquitard;
 6 - contaminants migration; Q - Quaternary; N - Neogene

The study area



Changes in the hydrochemical parameters against a background of the nitrate concentrations

1 - total hardness > 6.0 mval/l; 2 - sulphate > 70 mg/l.

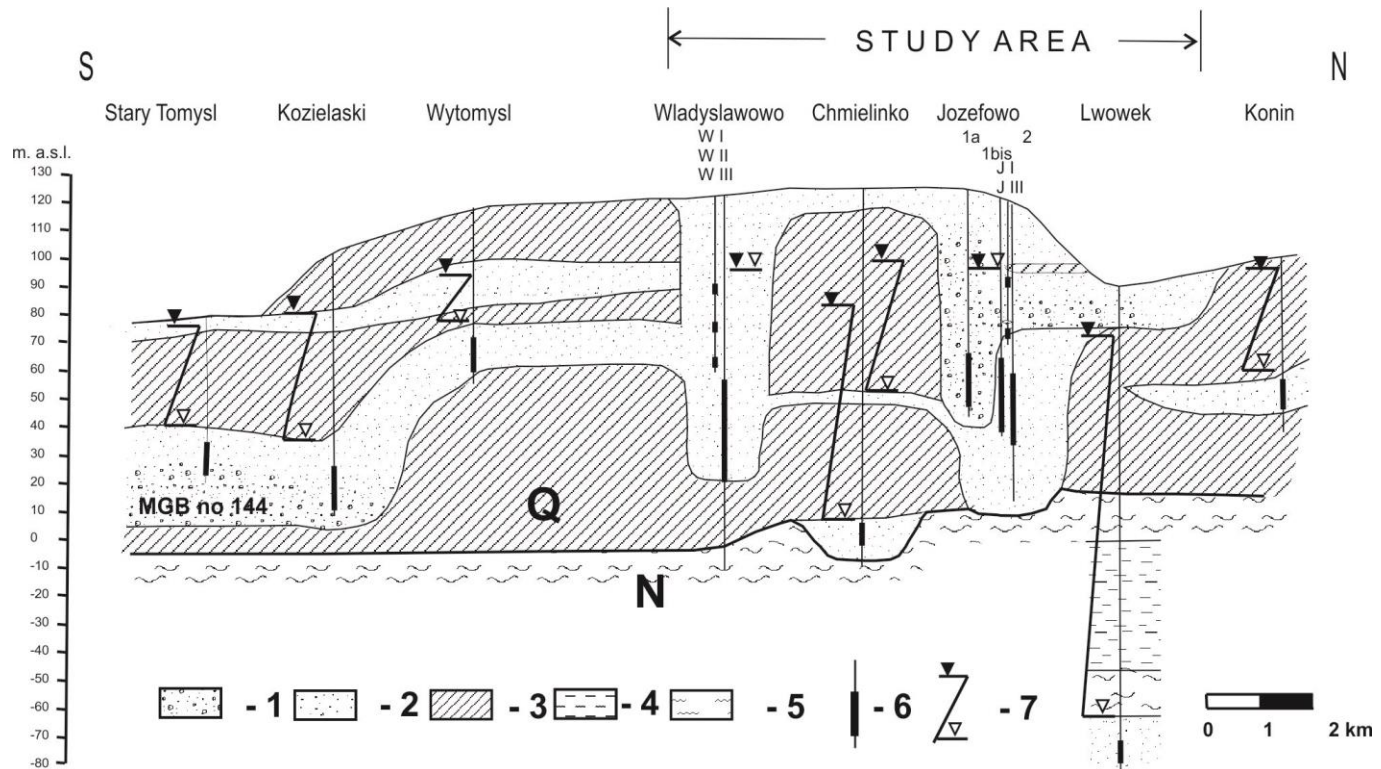




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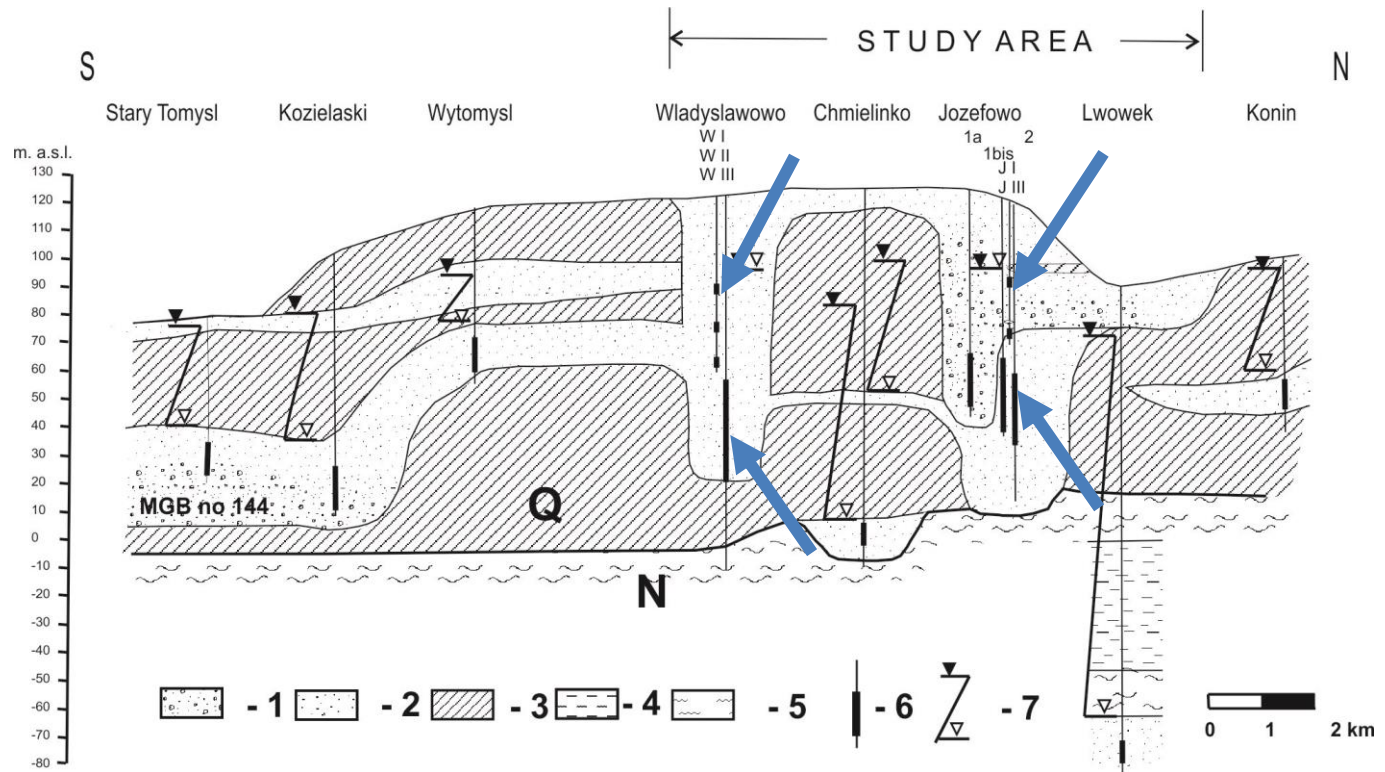
Methods



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Methods

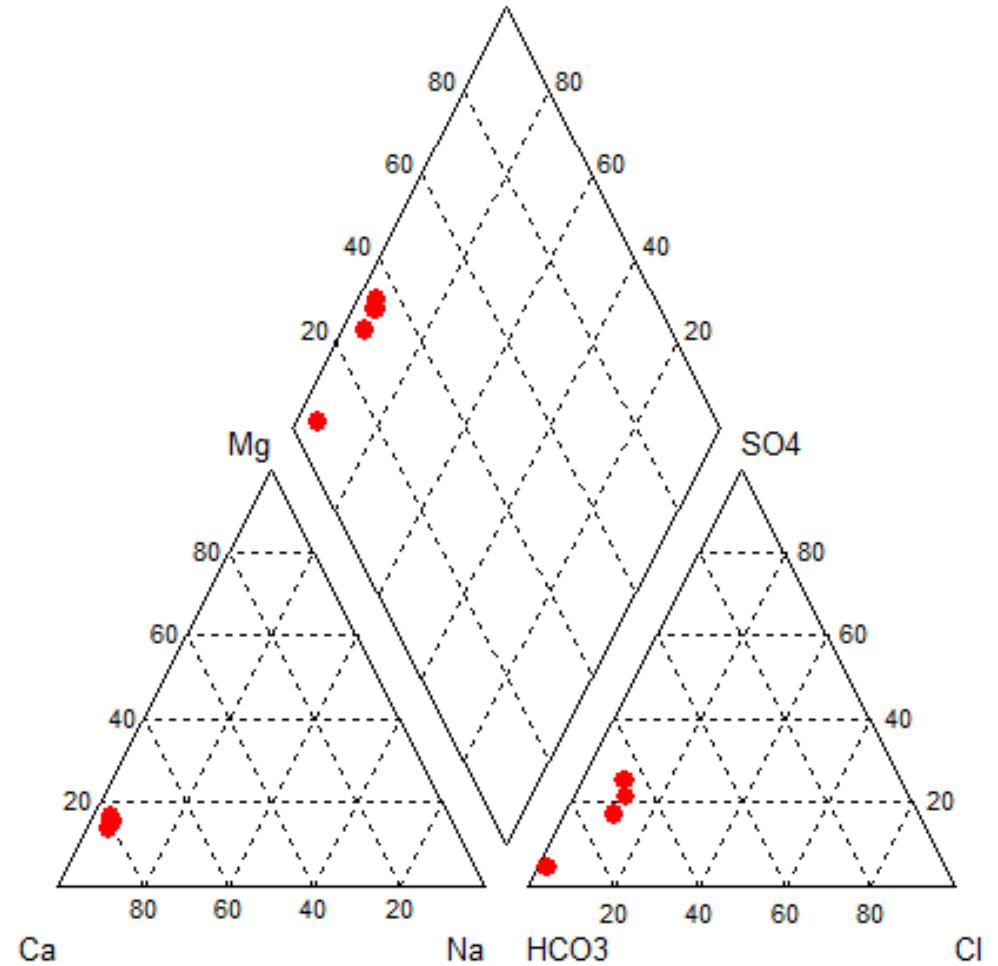




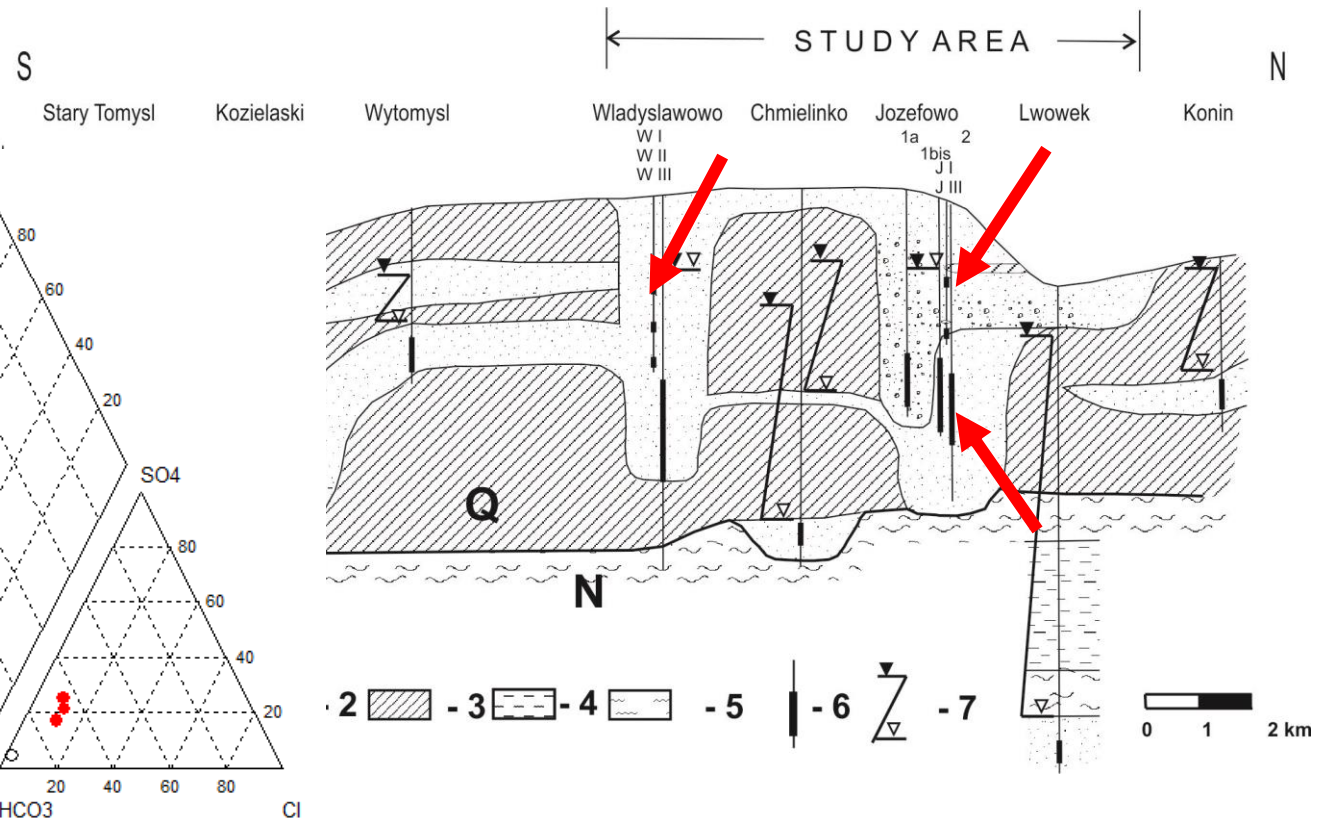
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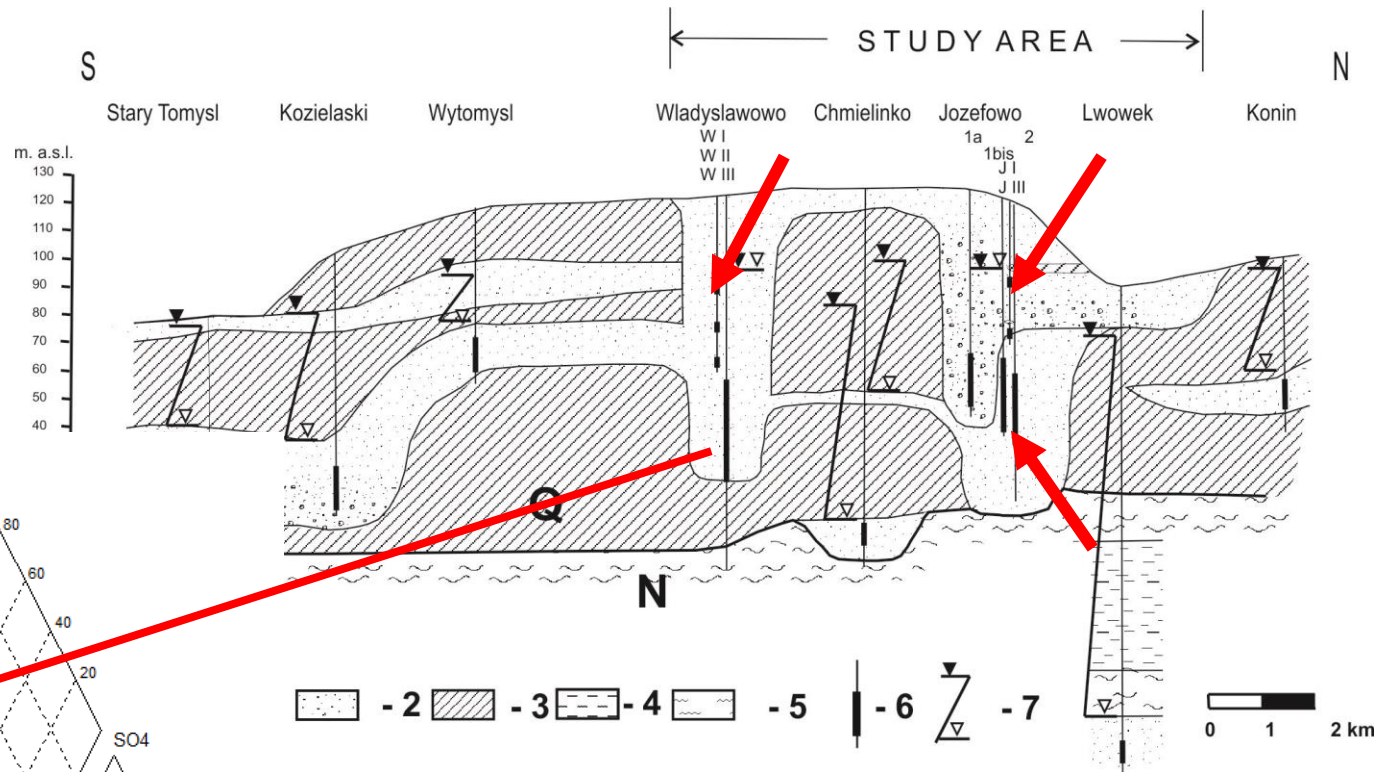
Results and discussion

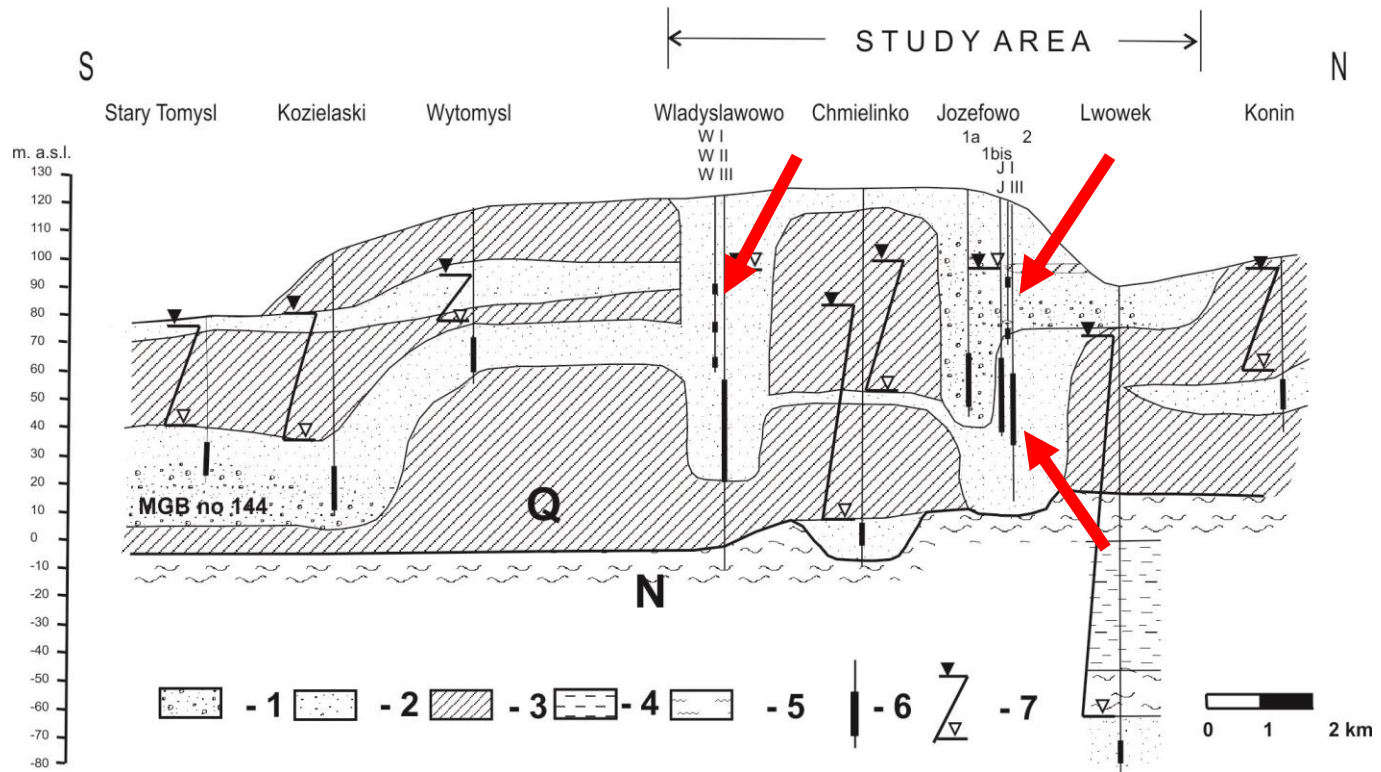


Results and discussion



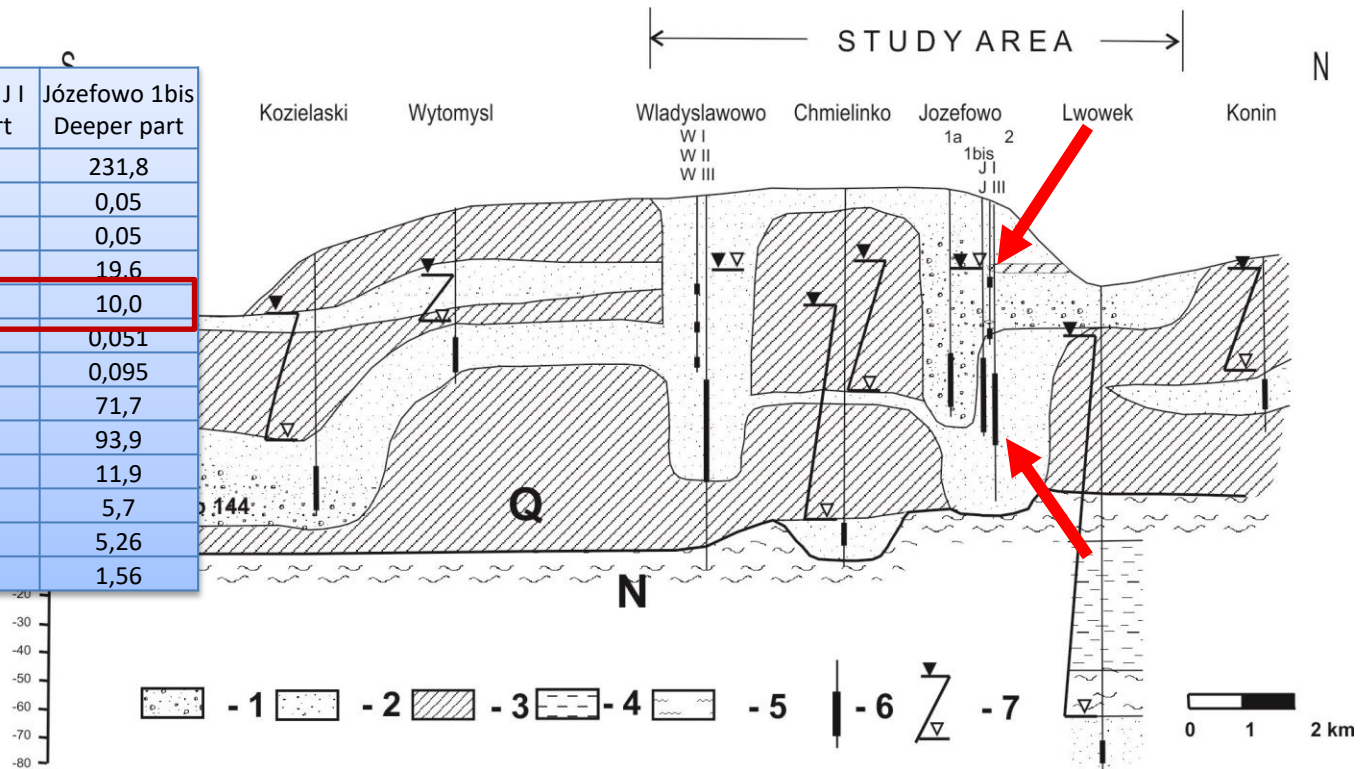
Results and discussion





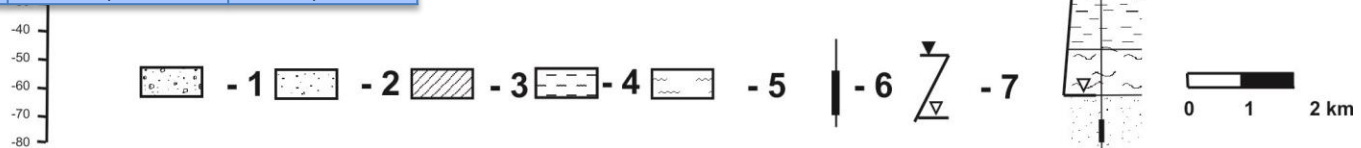
Results and discussion

		Józefowo J I Uper part	Józefowo 1bis Deeper part
Bicarbonates		262,3	231,8
Iron		0,04	0,05
Manganese		0,03	0,05
Chloride		24,0	19,6
NO ₃	mg/l	13,7	10,0
NO ₂		0,019	0,051
NH ₄		0,158	0,095
Sulphate		49,8	71,7
Calcium		95,9	93,9
Magnesium		11,3	11,9
Total Hardness	mval/l	5,7	5,7
Sodium		6,50	5,26
Potassium	mg/l	1,33	1,56



Results and discussion

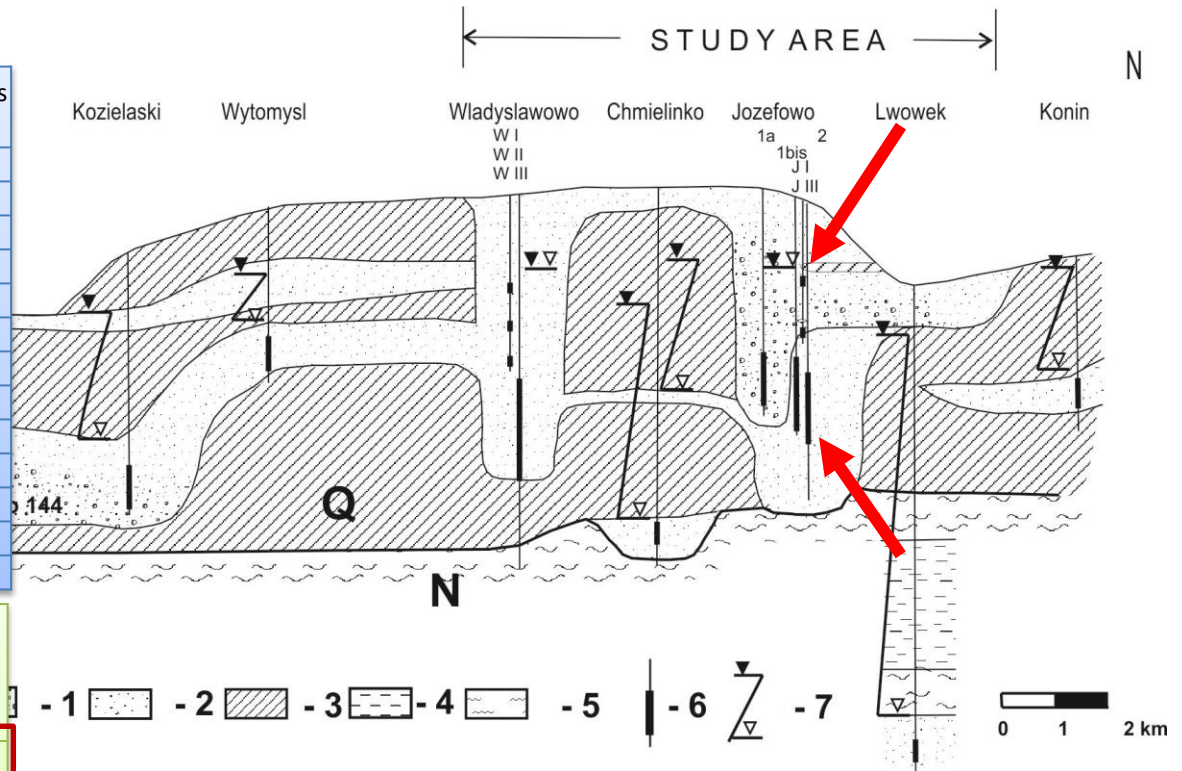
		Władysławowo W I Uper part	Władysławowo 1 Deeper part
Bicarbonates		237,9	274,5
Iron		0,05	1,68
Manganese		0,02	0,12
Chloride		24,6	3,29
NO ₃	mg/l	34,6	1,00
NO ₂		0,009	0,011
NH ₄		0,642	0,721
Sulphate		60,8	10,4
Calcium		102,4	75,8
Magnesium		10,7	8,94
Total Hardness	mval/l	6,0	4,5
Sodium		6,87	5,33
Potassium	mg/l	1,30	1,36



Results and discussion

		Józefowo J I Upper part	Józefowo 1bis Deeper part
Bicarbonates	mg/l	262,3	231,8
Iron		0,04	0,05
Manganese		0,03	0,05
Chloride		24,0	19,6
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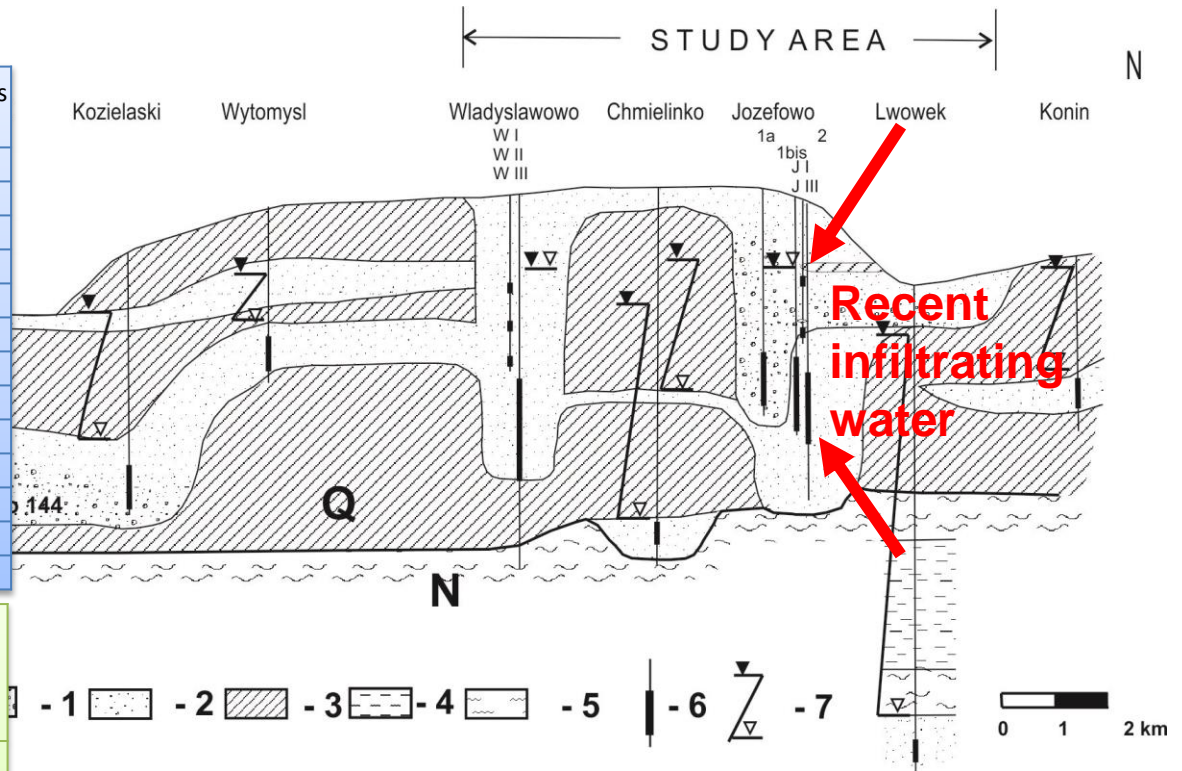
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Tryt [T.U.]	3,0 ± 0,3	4,0 ± 0,3
δ ¹³ C [‰]	-13,5	-12,1
C-14 [pmC]	65,8 ± 1,6	53,9 ± 1,6



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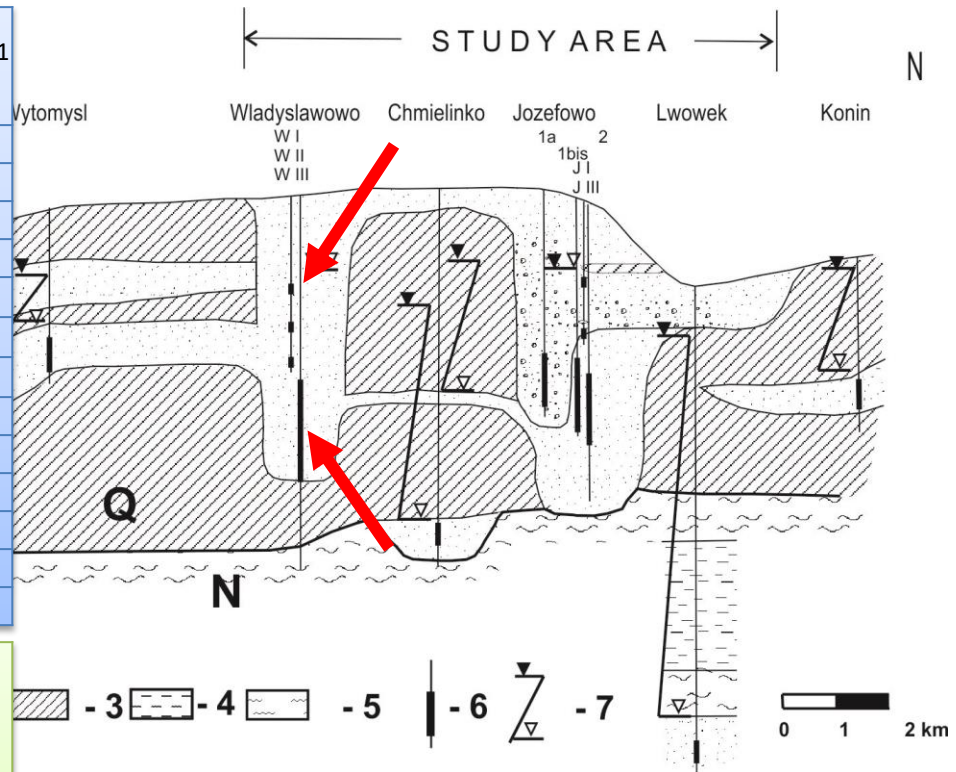
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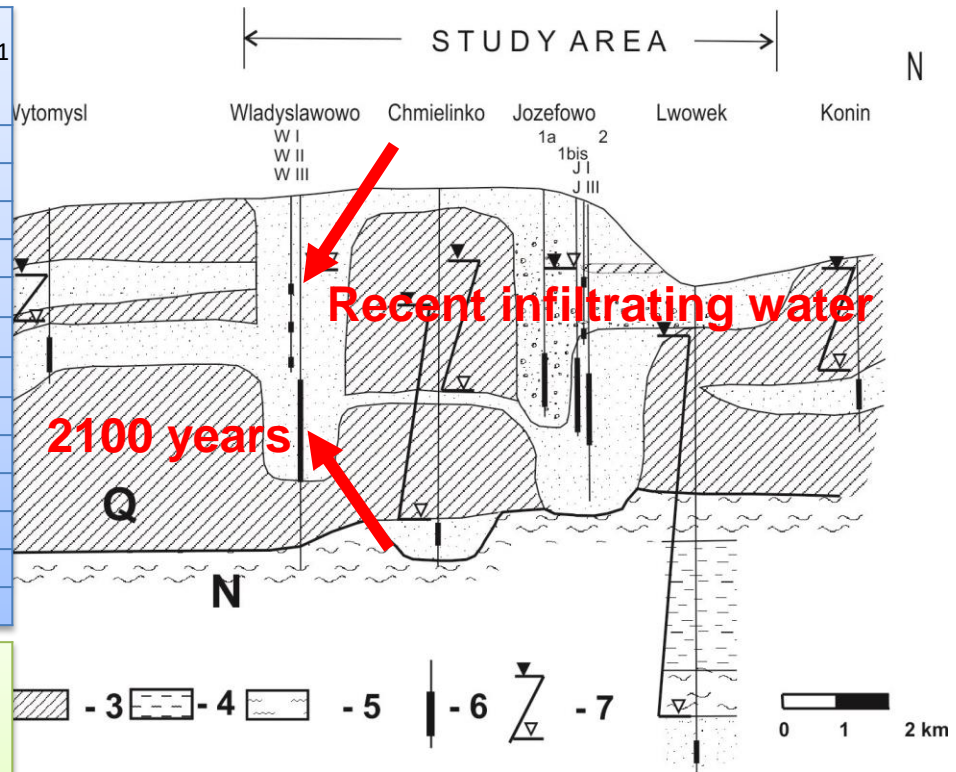
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C-14 [pmC]	64,9 ± 1,6	45,2 ± 1,6



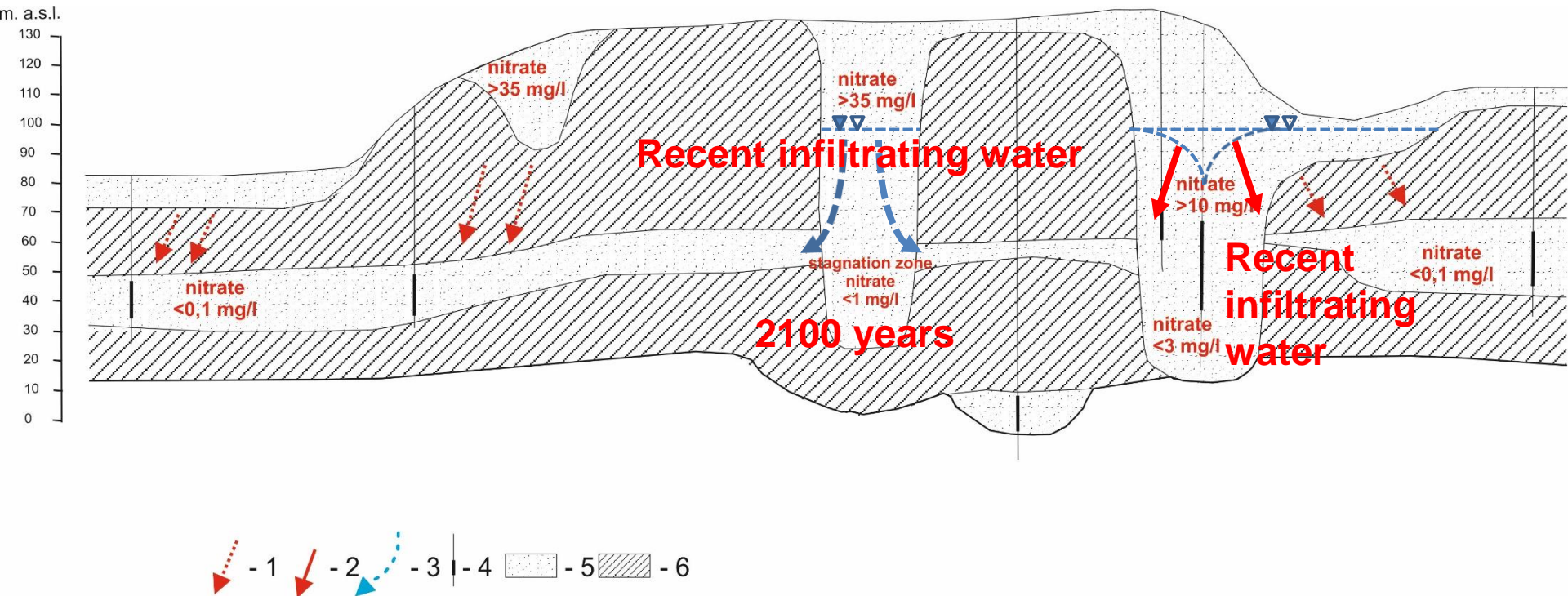
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Results and discussion



A conceptual model of the groundwater circulation and behaviour of the nitrate in the regional recharge zone of the Quaternary flow system

1 - The preferential aquifer recharge through the aquitard, 2 - the preferential aquifer recharge – the unconfined parts of the flow system and the regions of intensive groundwater exploitation, 3 - the aquifer recharge under natural groundwater flow conditions (without exploitation), 4 - wells in regions of intensive groundwater exploitation, 5 - aquifers, 6 - aquitard



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Conclusions

The groundwater chemistry occurring in the recharge zone of the Quaternary aquifers (Lwówek, Jozefowo region, Poland) is highly dependent on the conditions of the groundwater flow.



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The groundwater chemistry occurring in the recharge zone of the Quaternary flow system (Lwówek, Józefów region, Poland) is highly dependent on the conditions of the groundwater flow.

The conceptual model of groundwater circulation was formulated. It was documented that contamination detected in shallow part of the aquifer can migrate to the deep part because downward gradient (characteristic attribute of the regional recharge zones) enable to move the contaminants downward especially in the regions of groundwater extraction. At these regions the high nitrate concentration appear even at great depth (>100m).



Conclusions

The groundwater chemistry occurring in the recharge zone of the Quaternary flow system (Lwówek, Jozefowo region, Poland) is highly dependent on the conditions of the groundwater flow.

Based on research performed the conceptual model of groundwater circulation was formulated. It was documented that contamination detected in shallow part of the aquifer can migrate to the deep part of the aquifer because downward gradient (characteristic attribute of the regional recharge zones) enable to move the contaminants downward especially in the regions of groundwater extraction. At these regions the high nitrate concentration appear even at great depth ($>100\text{m}$).

It was also documented that in the regions under natural gradients existence (without water extraction) the recharge in shallow part of the aquifer is also intensive but young water do not reach deep part of the flow system. In this condition in deep part of the aquifer typical stagnation zone exists (as defined by Toth, 1963), what is manifested by completely different groundwater chemistry than in shallow part of the aquifer.



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The presented research is a clear example how chemical data can help to investigate groundwater circulation.



Use of chemical data for verification of the groundwater flow conditions (Lwówek region, Poland)

Acknowledgments: The paper was completed by analysis supported by the the Ministry of Science and Higher Education Poland (grant no. 2164/BT02/2007/33) and by support of the National Science Centre Poland (grant no. 2014/15/B/ST10/00119).

Thank you for attention !!!