ESF Project „*Establishment of interdisciplinary scientist group and modelling system for groundwater research*”

The visualisation of groundwater chemical composition using RGB scale, example from D12 aquifer, Latvia

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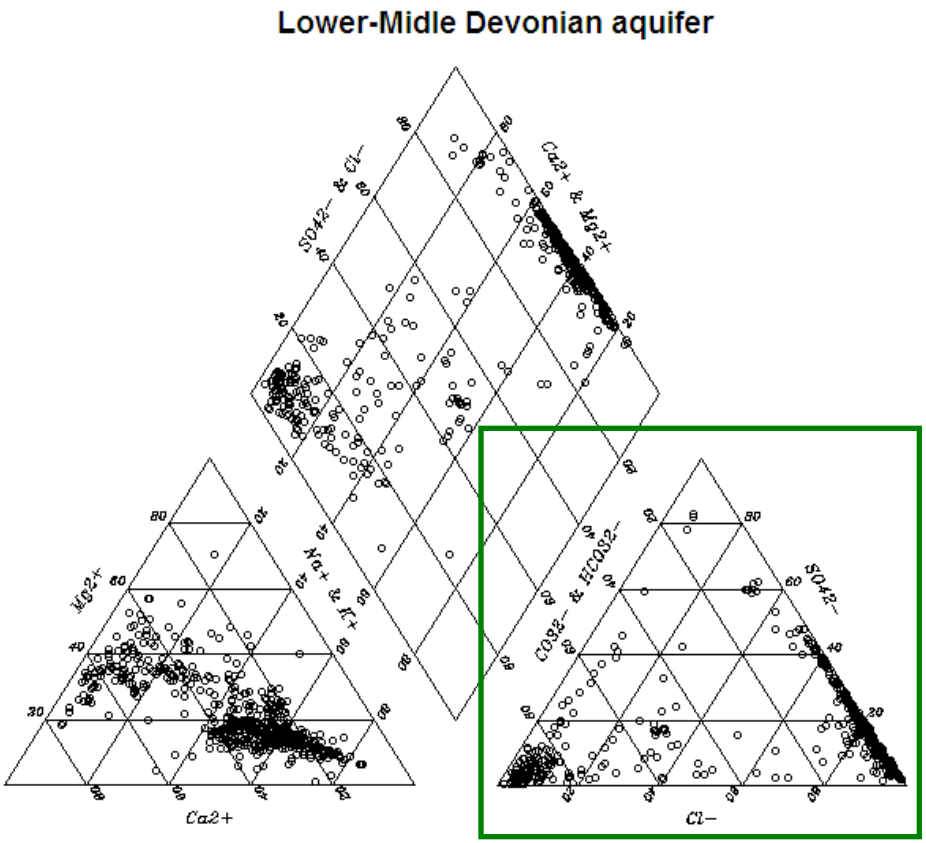
- Introduction – Piper diagram
- Introduction – RGB
  - The piper analogy: fixed summary intensity
  - There is more: full spectrum
- How does it look on the map and cross section

The Piper diagram



- Each of two lower triangles illustrate the relative concentrations of three basic components of the natural waters:
  - Anions Cl^-, SO_4^{2-}, HCO_3^-
  - Cations: Ca^{2+}, Mg^{2+} and $Na^+ + K^+$
- It is assumed that these components make up 100%
- The information about total water mineralization is lost

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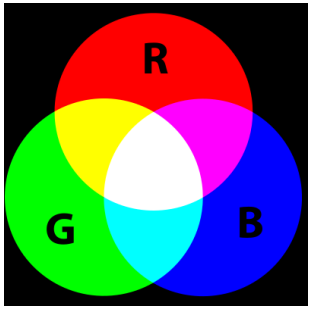
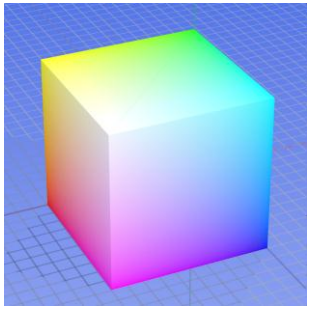


RGB colour space



- Three base colours (Red, Green, Blue) that are mixed additively
- Originating in the colour photography well before the onset of digital era
- A relative scale
- In digital format each colour value usually is in range between 0 and 255
- The value of each base colour is stored separately
- The relative brightest of each colour and the total colour intensity can be used instead
- If the value of all base colours is 0, then we have black, and if all are 255 – we have white; in between there is thousands of tones

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Piper diagram and RGB colour space

- The triangular diagrams of Piper plot and the RGB colour space is remarkably similar: we can use the RGB colour to show the concentrations of three components in the groundwater

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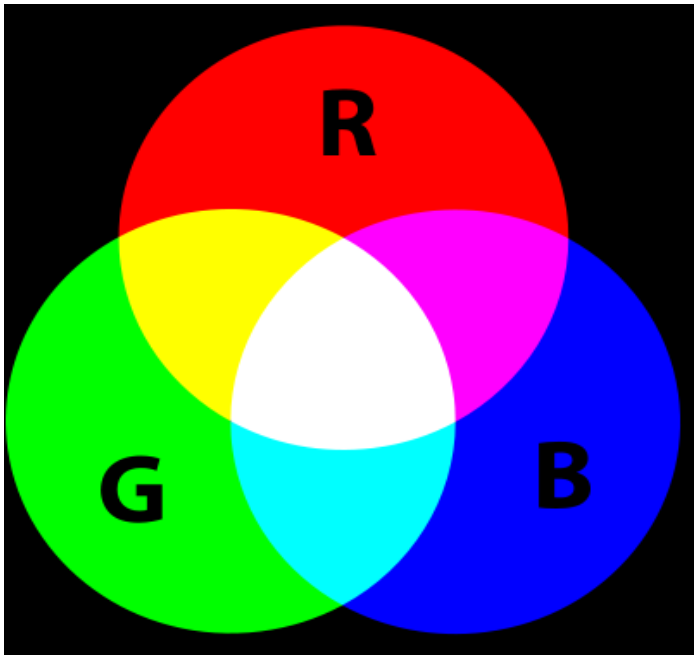
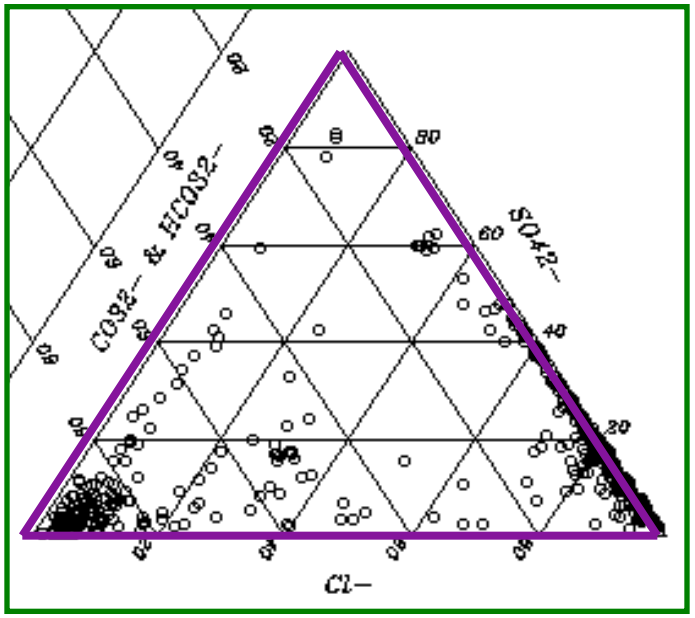
RGB colour space and Piper diagram





- The triangular diagrams of Piper plot and the RGB colour space is remarkably similar: we can use the RGB colour to show the concentrations of three components in the groundwater

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http://en.wikipedia.org/wiki/RGB

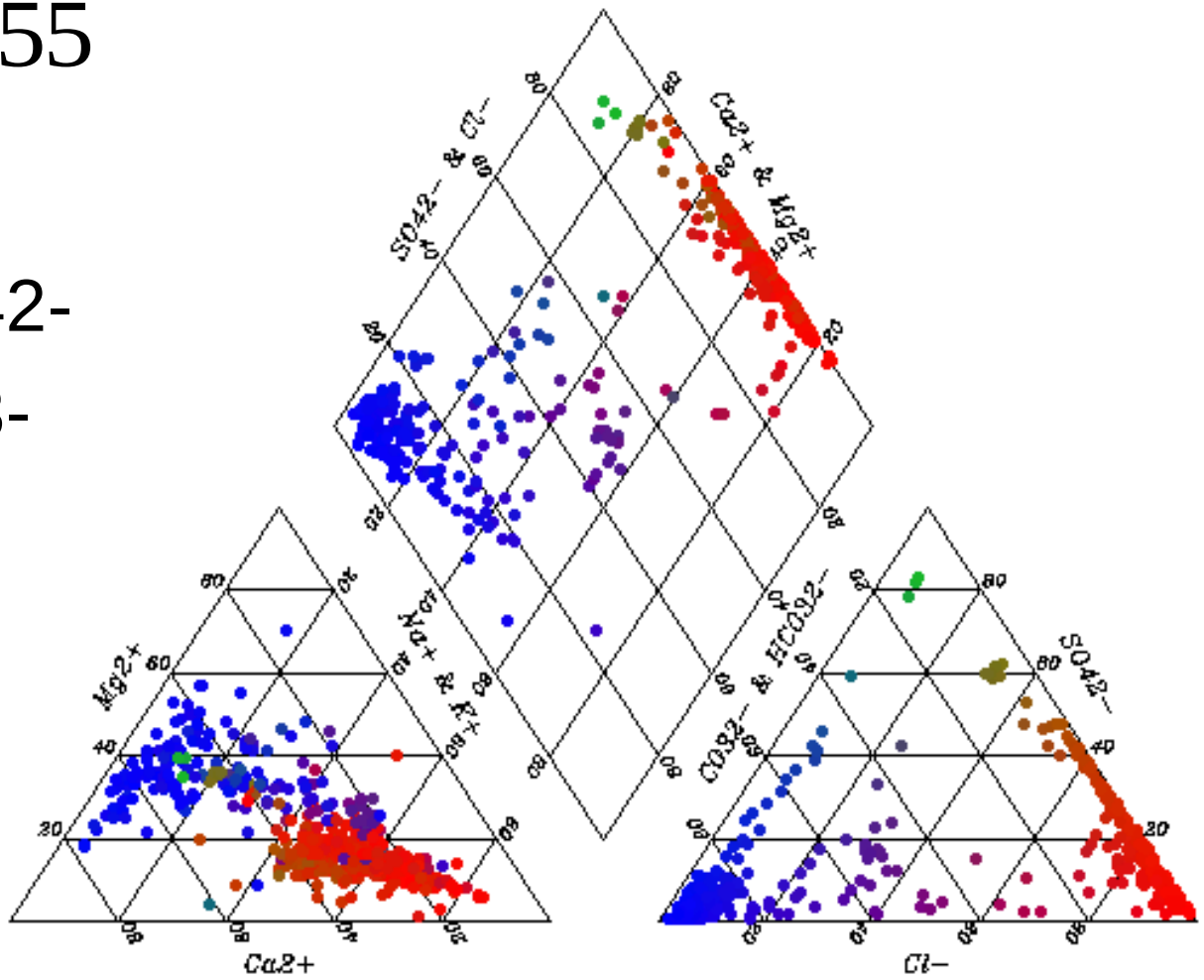
Wikipedia, the free encyclopedia

Piper to RGB: Fixed summary intensity

$$HCO_3^- + SO_4^{2-} + Cl^- = 100\%$$

$$B + G + R = 255$$

- Red for Cl-
- Green for SO42-
- Blue for HCO3-



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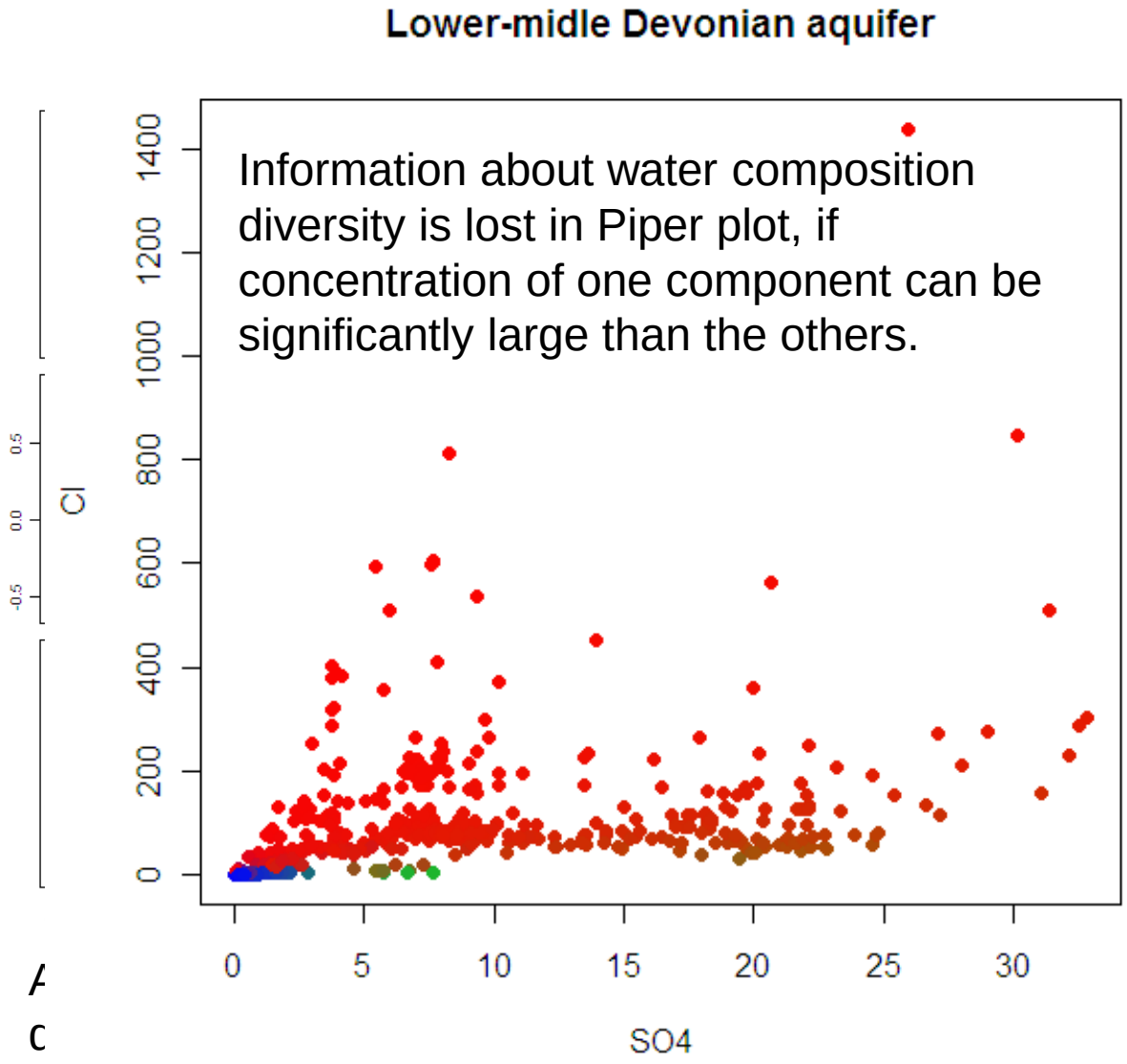
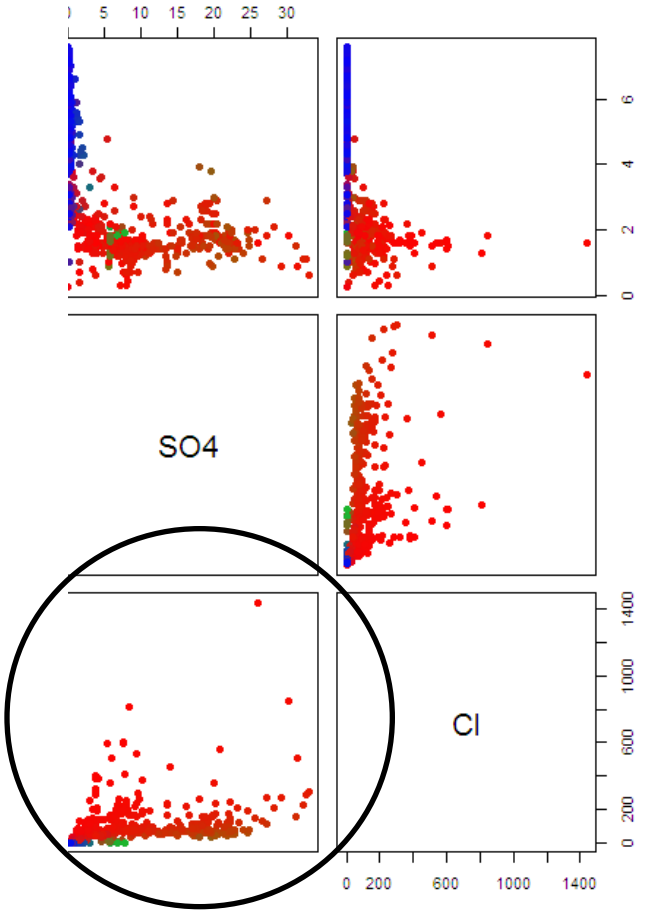
Piper to RGB: Fixed summary intensity





contrasting solubility of

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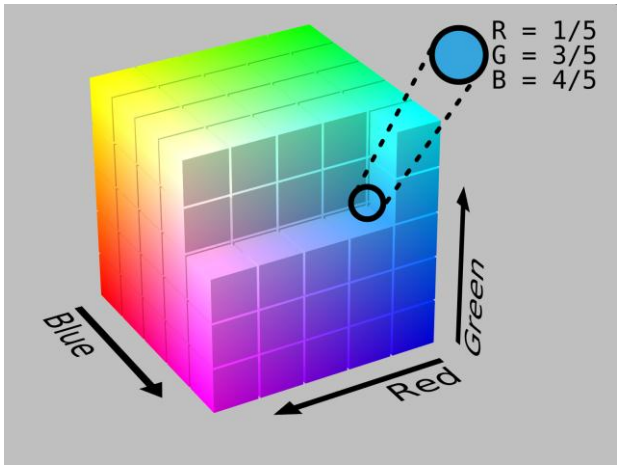
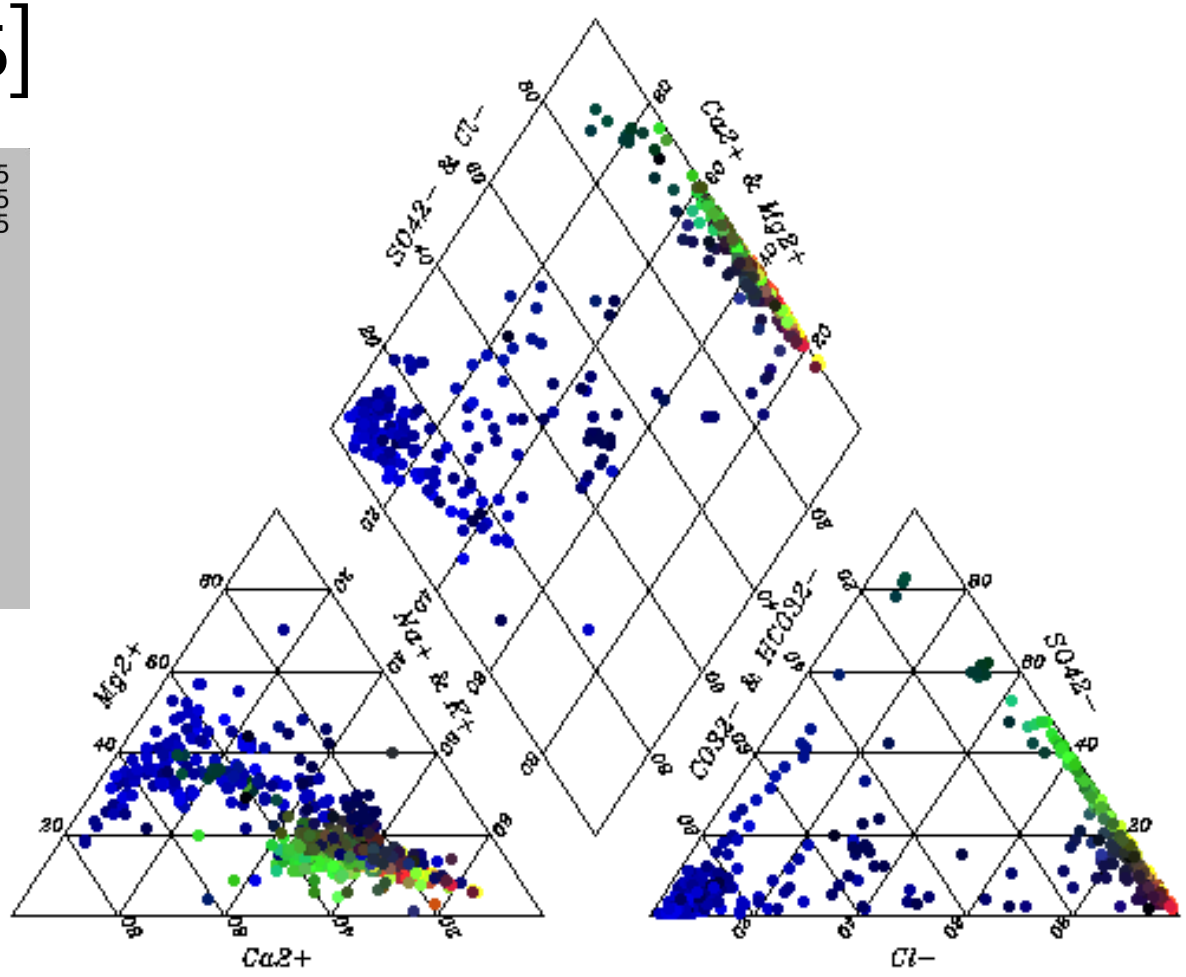
There is more: full RGB spectrum

$$HCO_3^- + SO_4^{2-} + Cl^- = [0, const](mmol - ekv/l)$$

$$B + G + R = [0,765]$$



http://en.wikipedia.org/wiki/RGB_color_spaces, Wikipedia, the free encyclopedia



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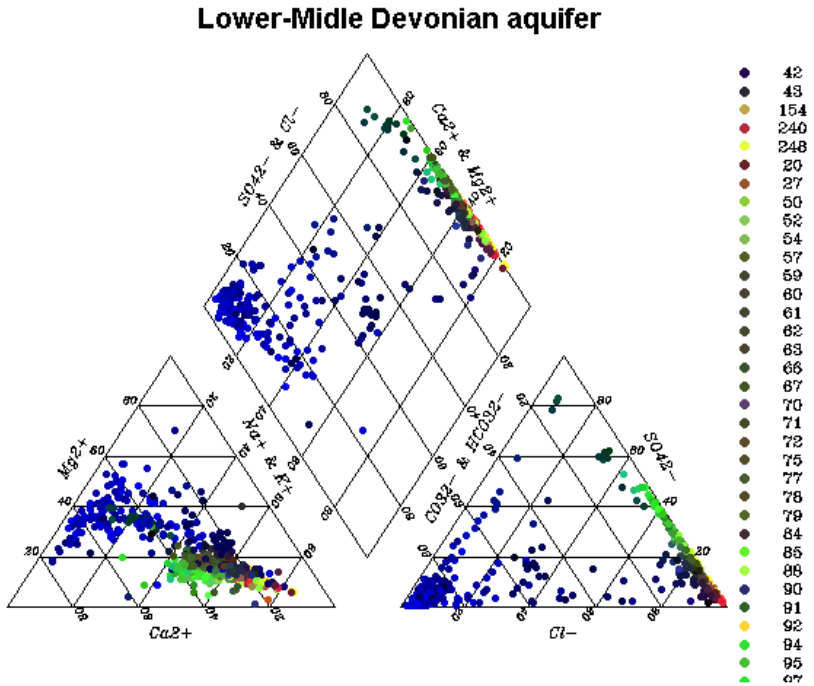
There is more: full spectrum

- Red for Cl^- at maximum concentration
- Yellow for Cl^- – SO_4^{2-} water
- Green for SO_4^{2-} at maximum concentration
- Magenta for SO_4^{2-} – HCO_3^- water
- Blue for HCO_3^- at maximum concentration
- Cyan for Cl^- – HCO_3^- water



$$B + G + R = [0{,}765]$$

$$HCO_3^- + SO_4^{2-} + Cl^- = [0, \infty](mmol - ekv/l)$$

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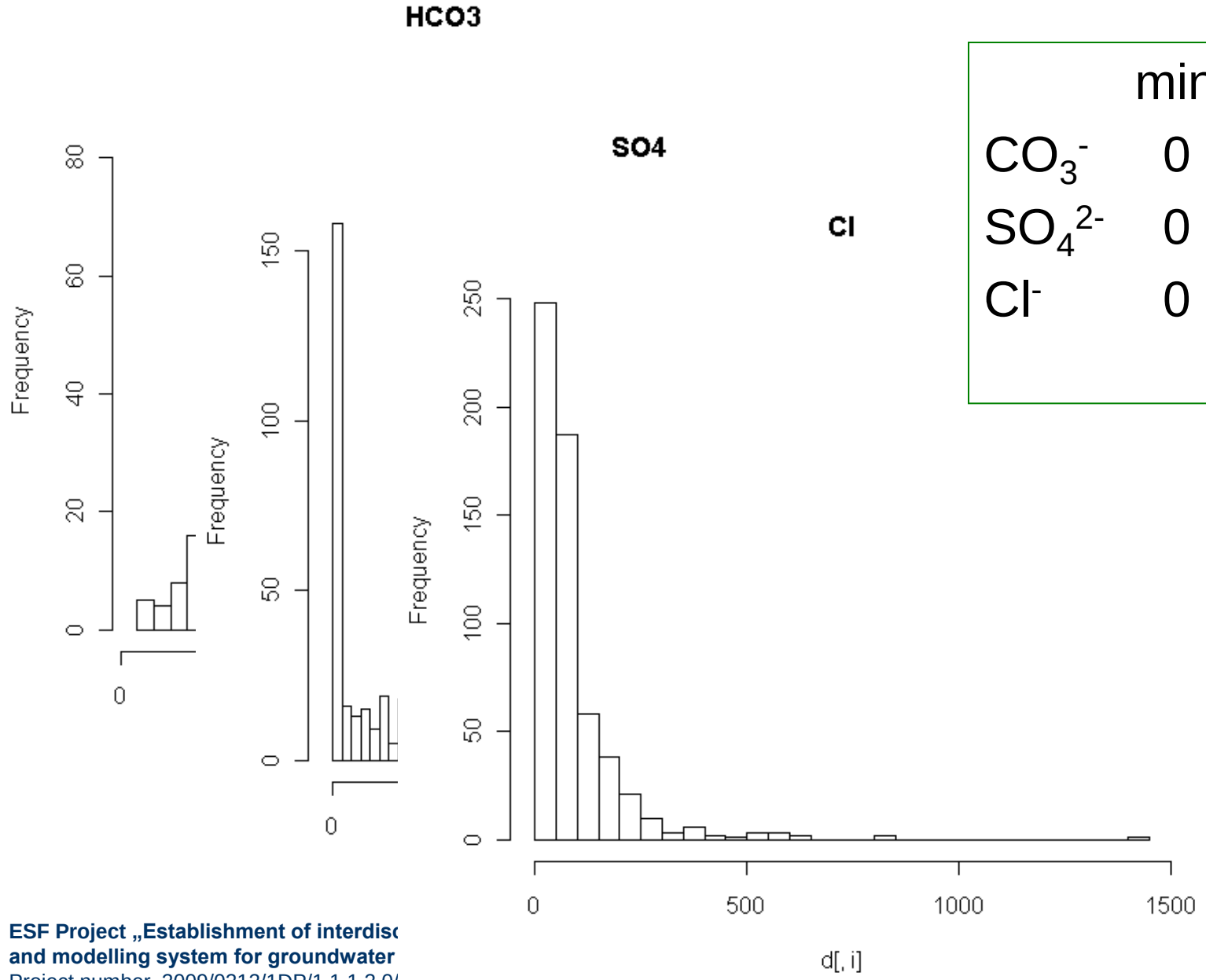
Arbitrary limits, one basis of histograms



	min	max
CO_3^{-}	0	8
SO_4^{2-}	0	25
Cl^{-}	0	200
		(mmol/l)

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and modelling system for groundwater
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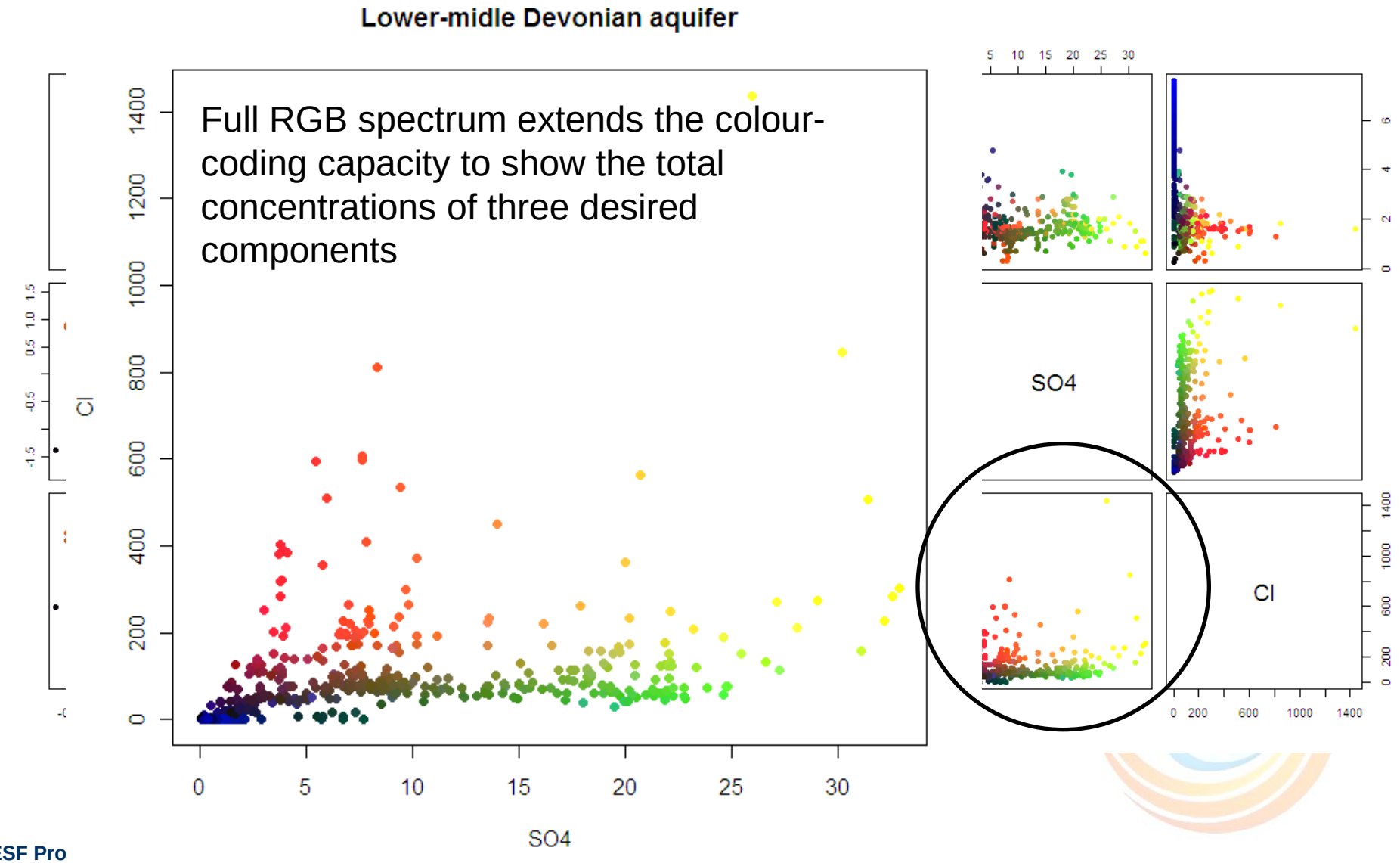
Piper to RGB: full spectrum



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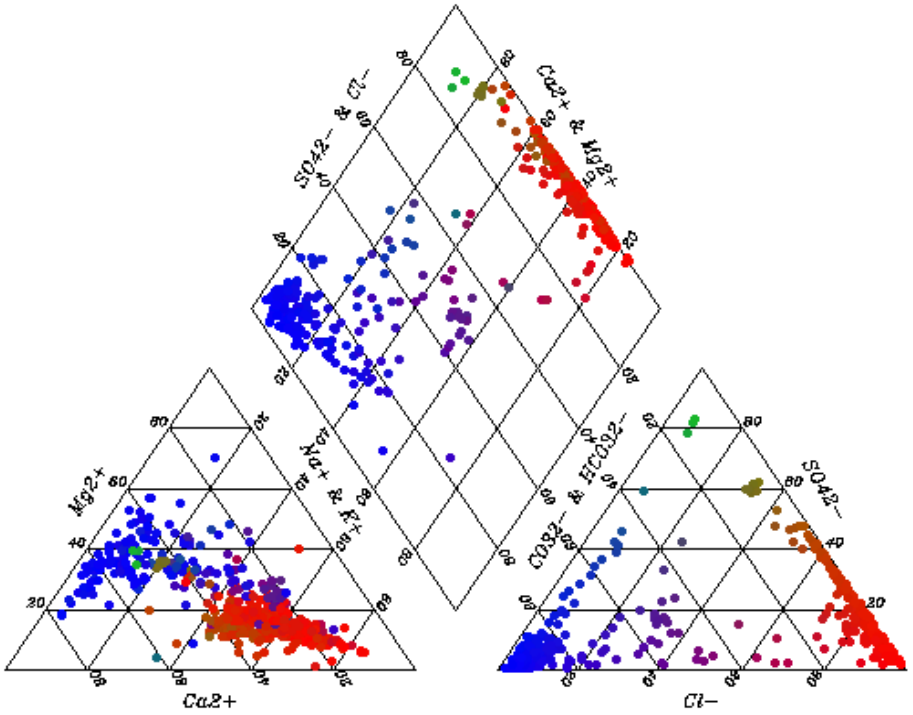
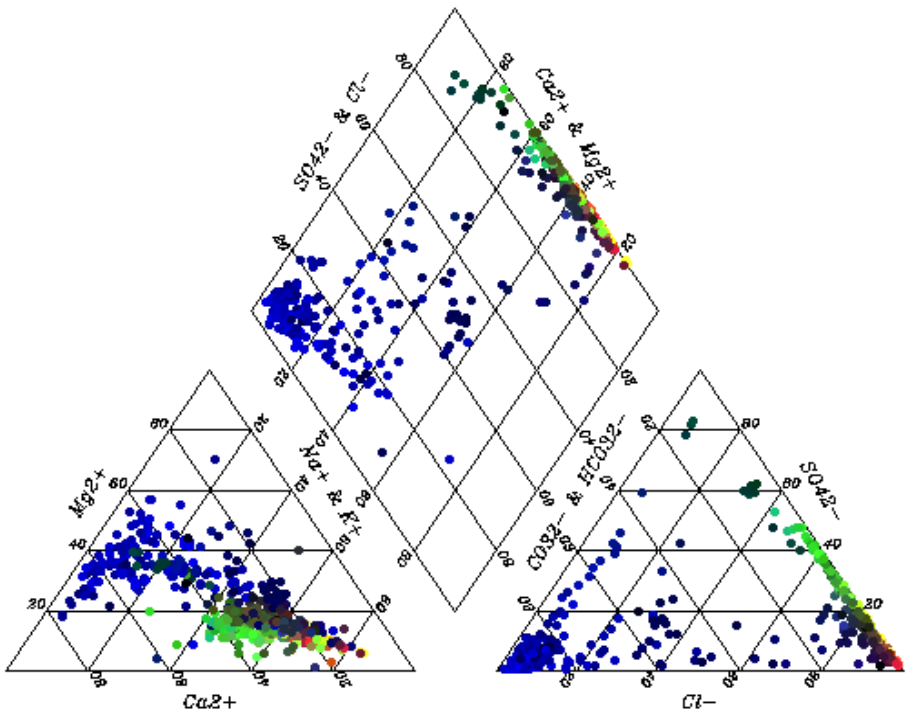
There is more: full RGB spectrum





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What about the Lower-Middle Devonian?

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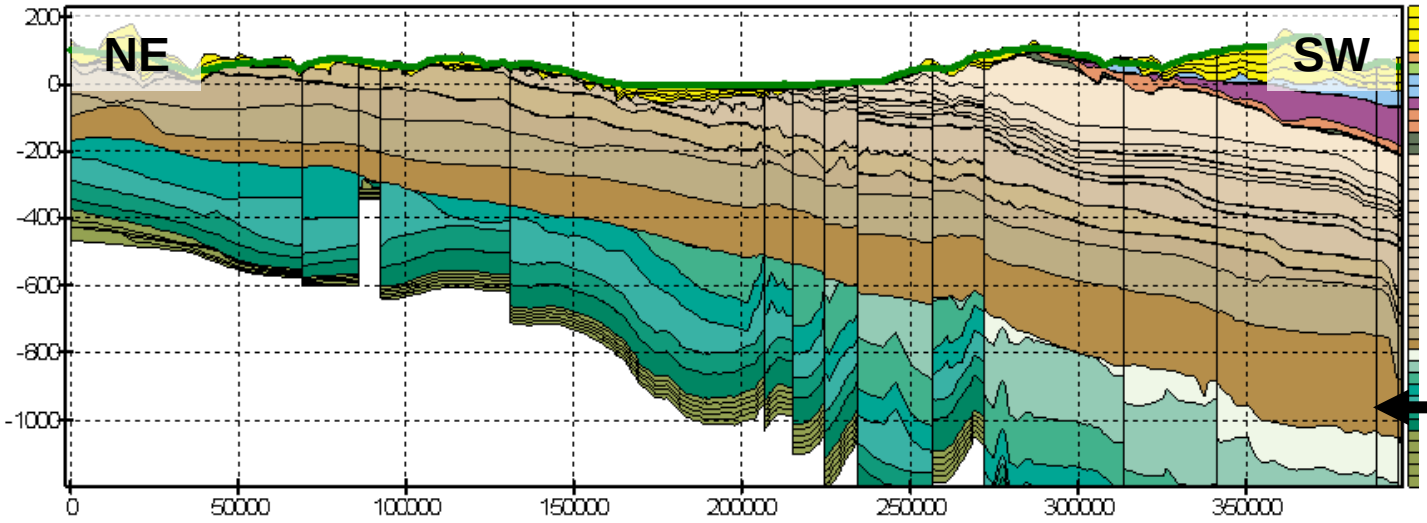
Lower-middle Devonian aquifer



D_{1-2} aquifer

- Terigenous sediments: sandstones, siltstones and clays
- Confined by Narva regional aquiclude
- Rēzekne, Pērnava, Ķemeri and Garždi formations

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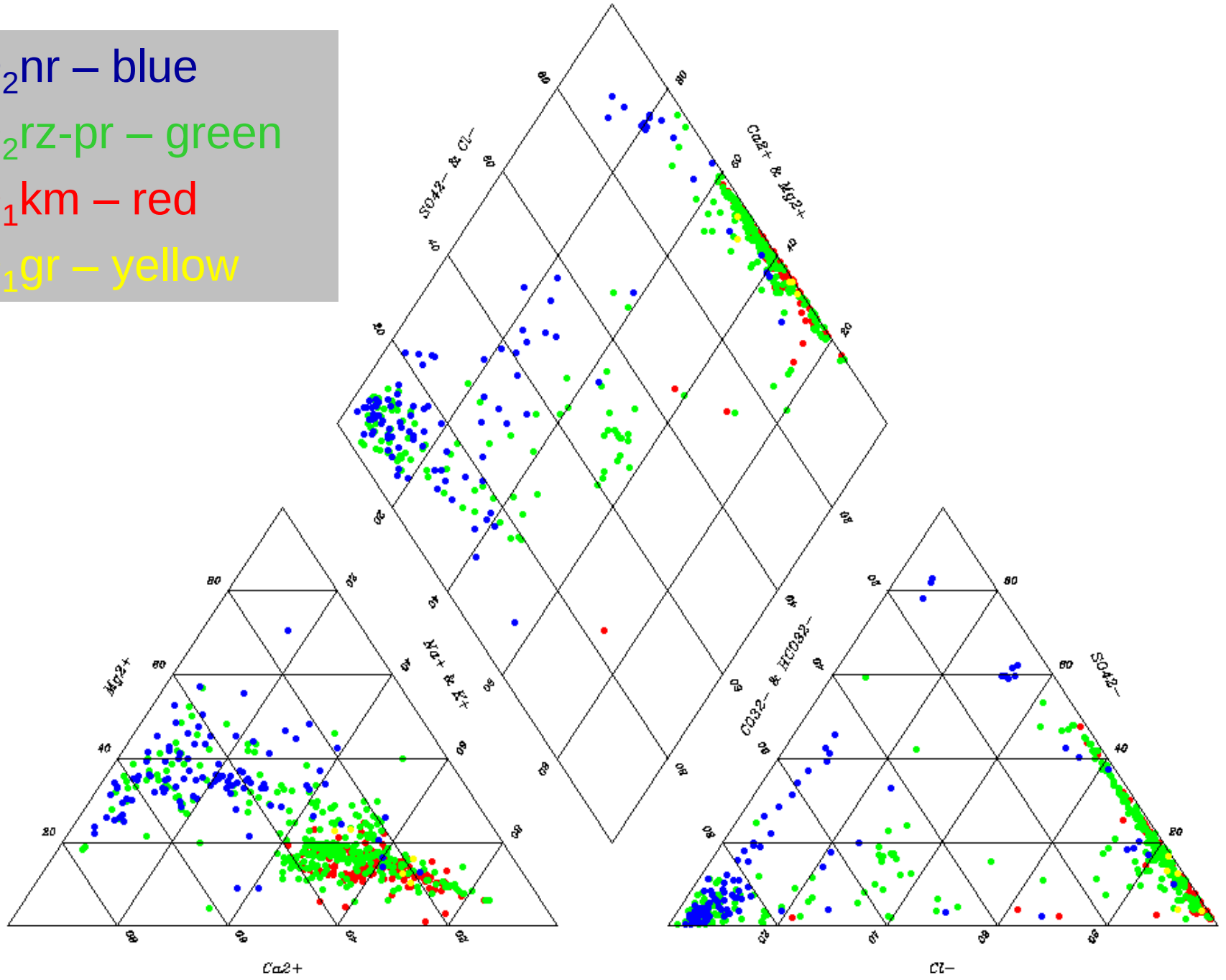
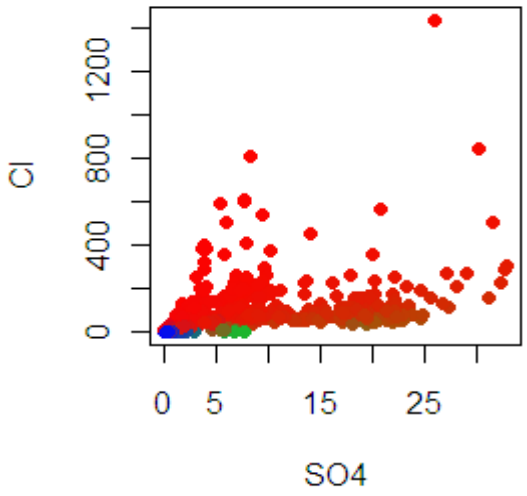
- D_2nr – blue
- D_2rz-pr – green
- D_1km – red
- D_1gr – yellow



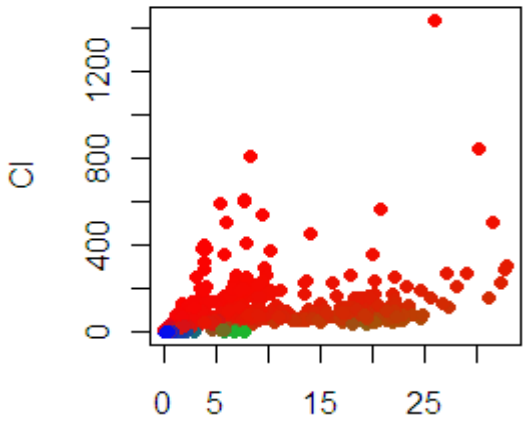
Relative colour scale

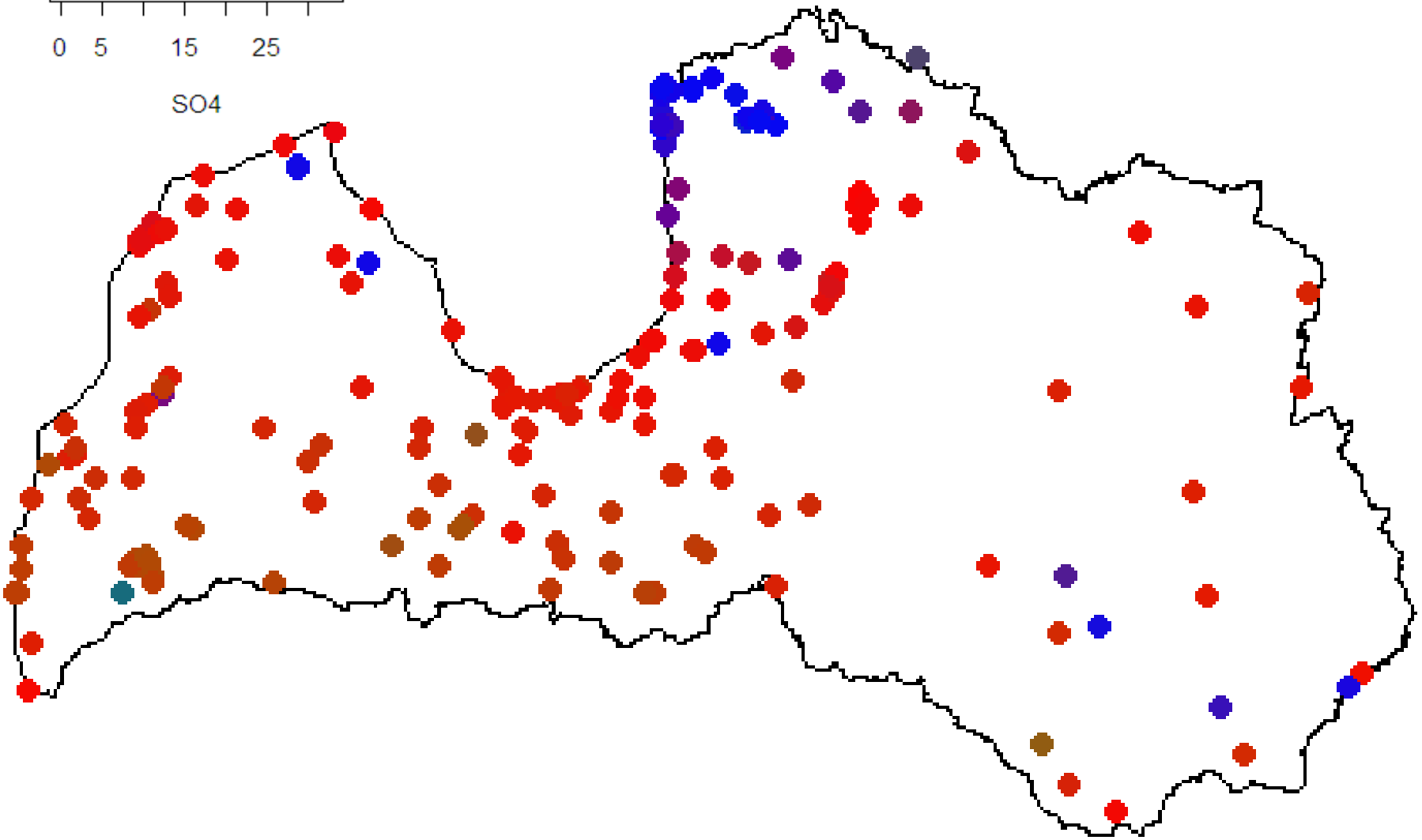
The direct Piper diagram analogy
for composition colour coding

D_2nr, relative colour scale

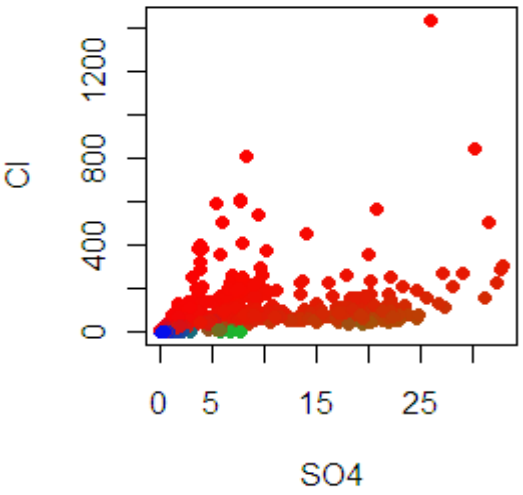


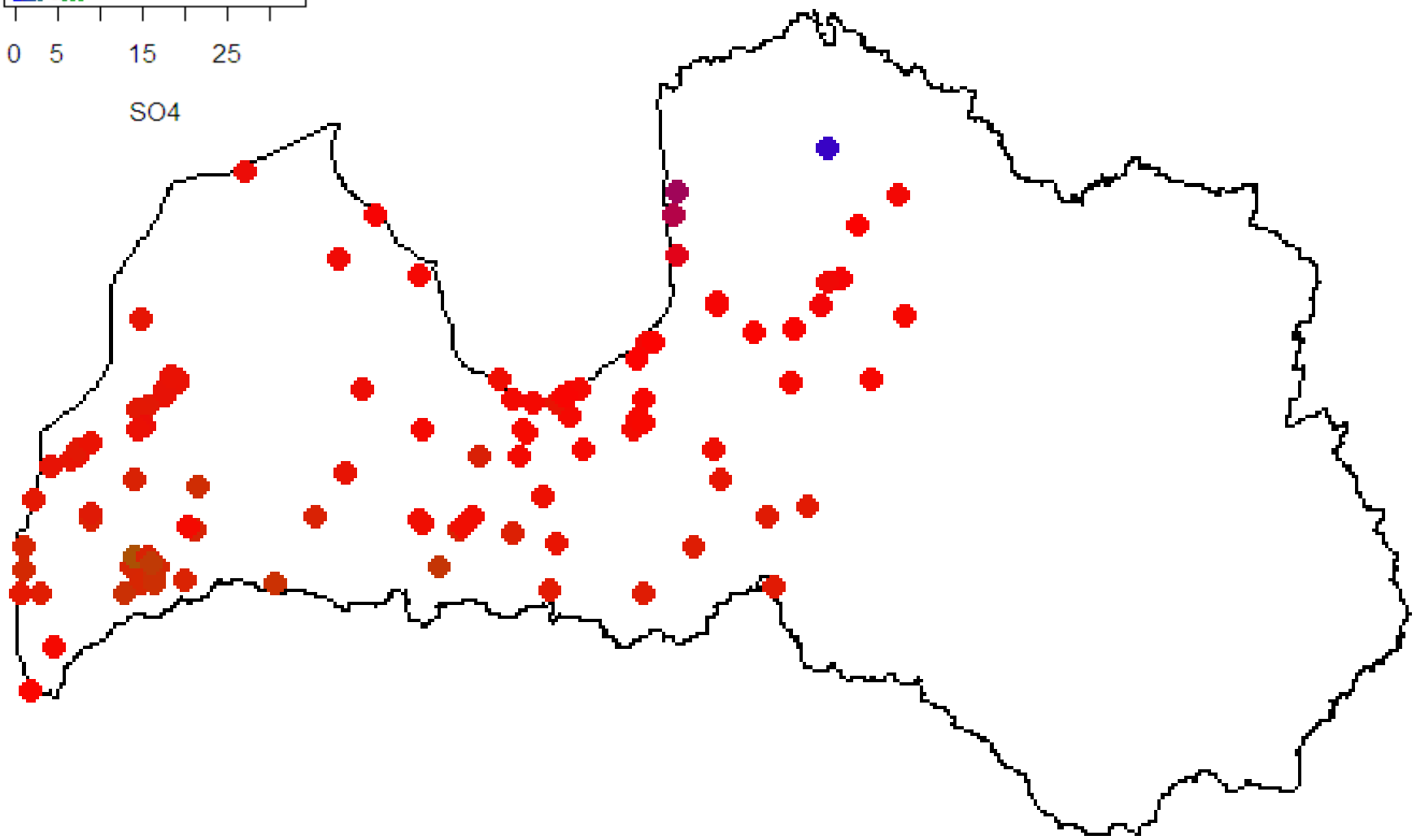
D_2rz-pr, relative colour scale



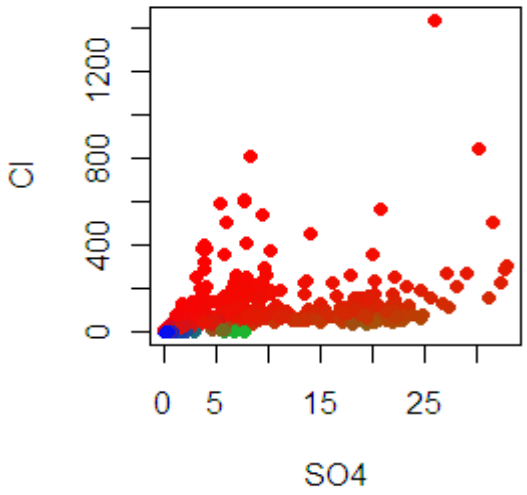


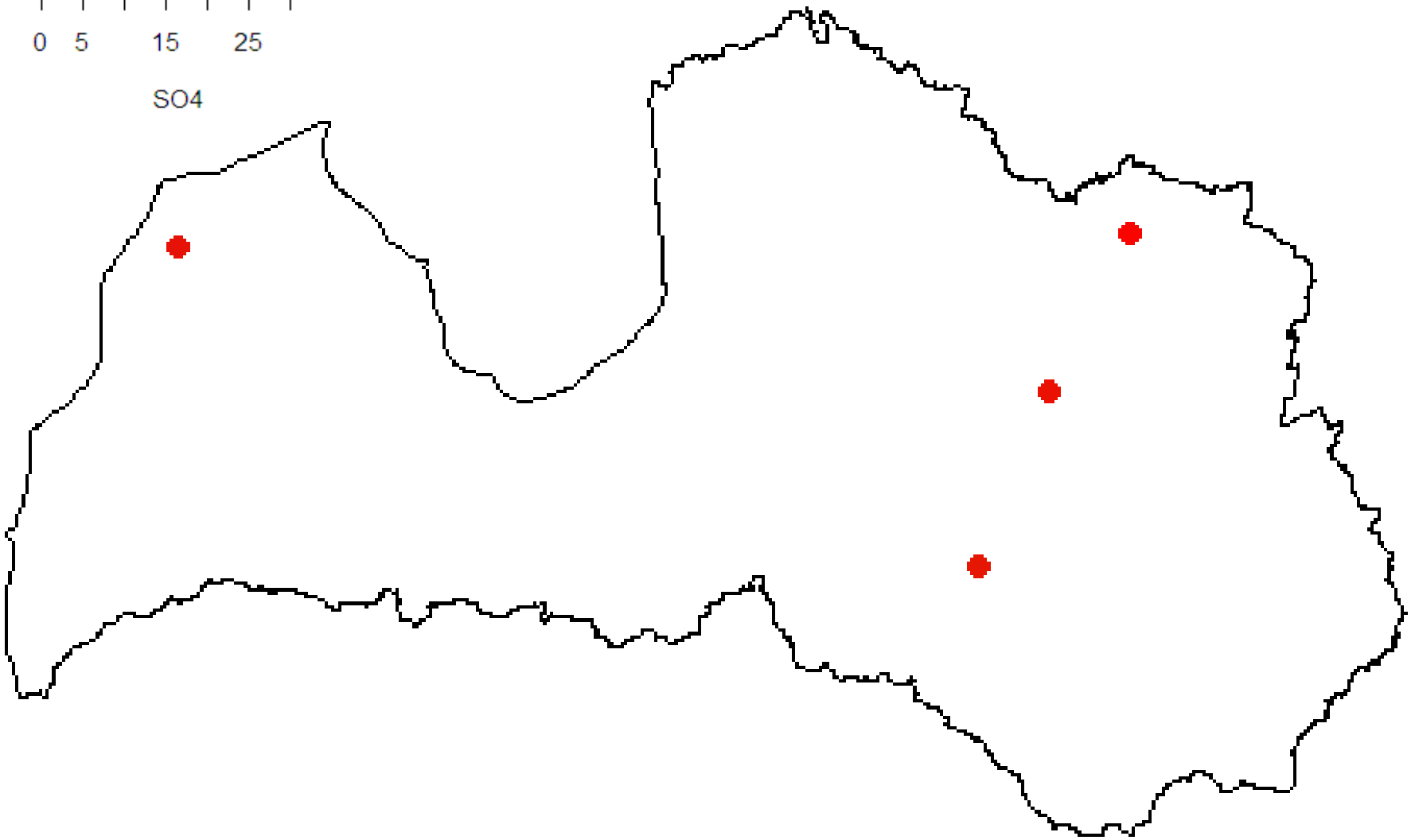
D_1km , relative colour scale





D_1**gr**, relative colour scale

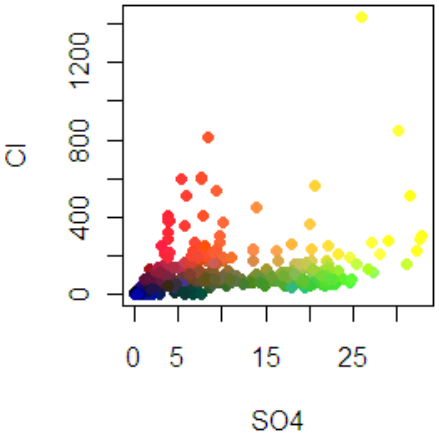




Absolute colour scale

The use of full RGB spectrum for composition colour coding

D_2nr, absolute colour scale



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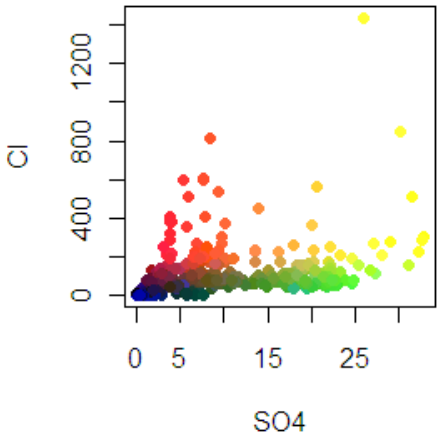
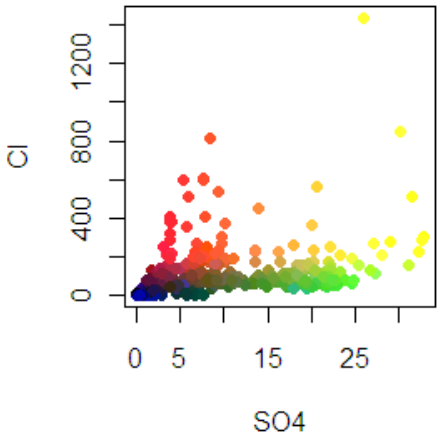
D_2rz-pr, absolute colour scale



D_1km, absolute colour scale



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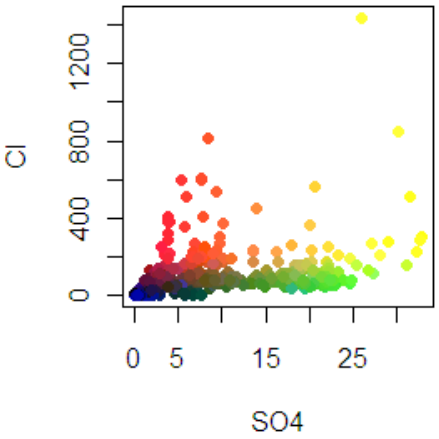
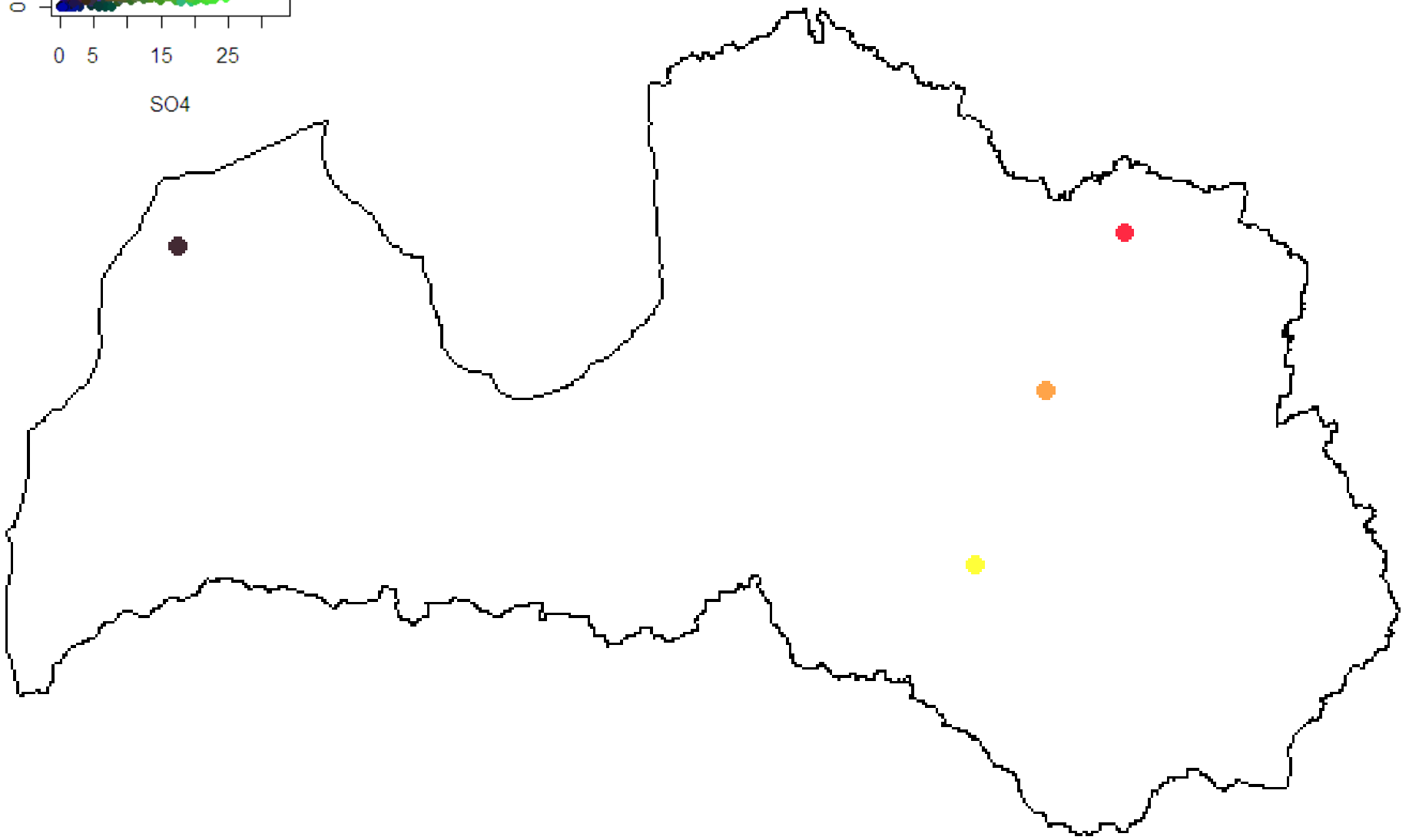
D_1gr, absolute colour scale





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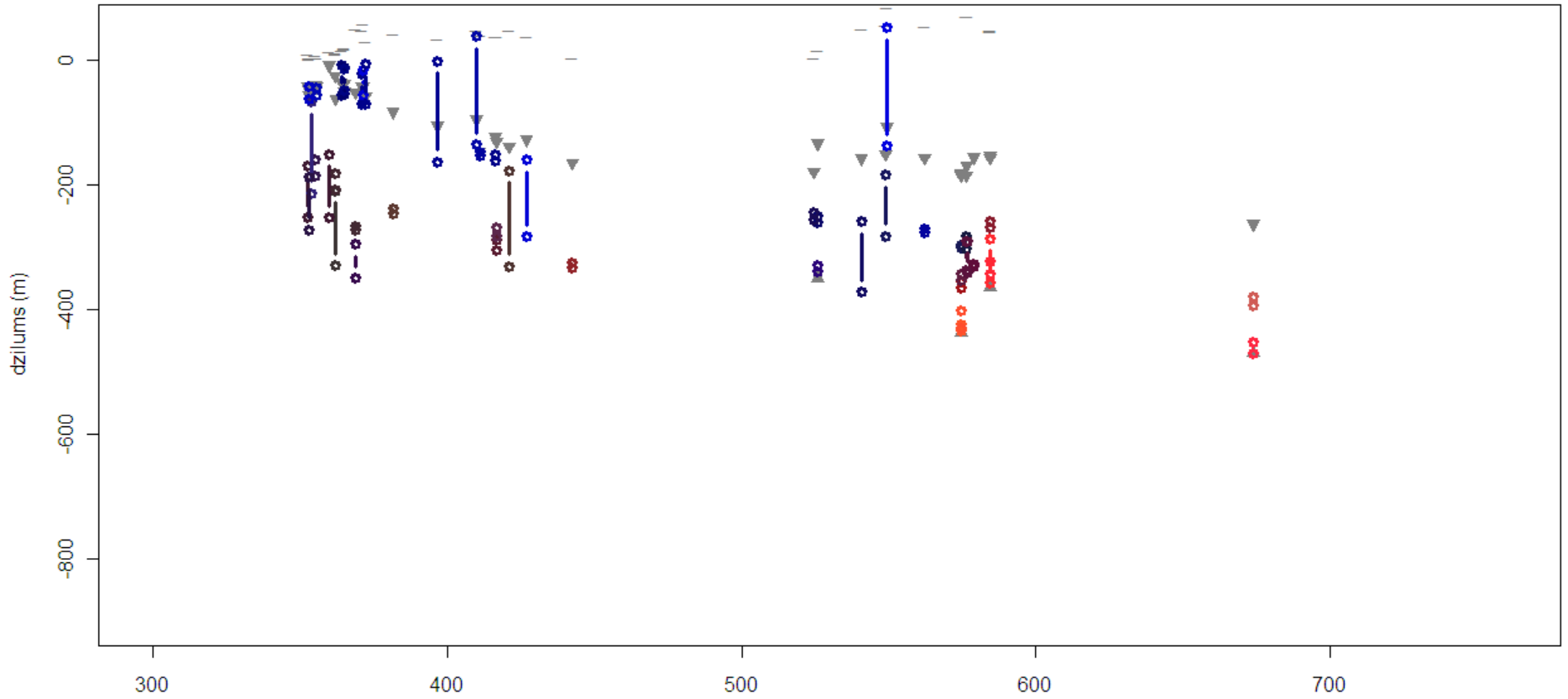
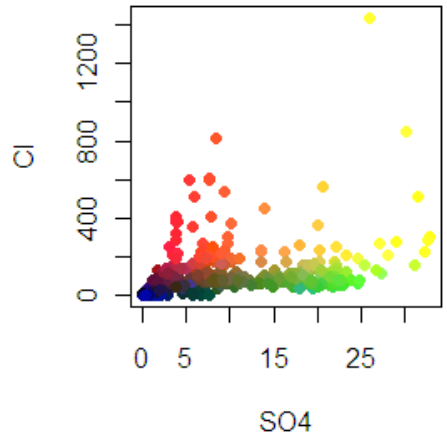
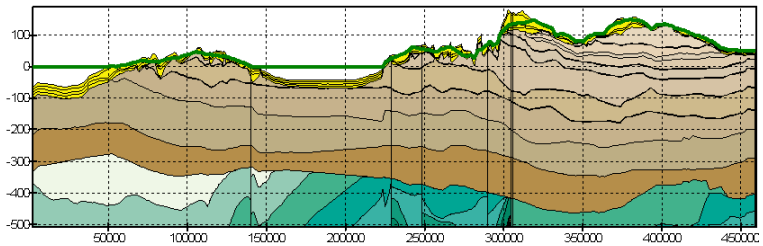
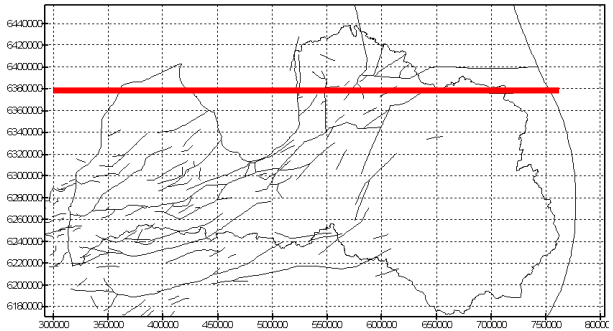
Water composition in cross section









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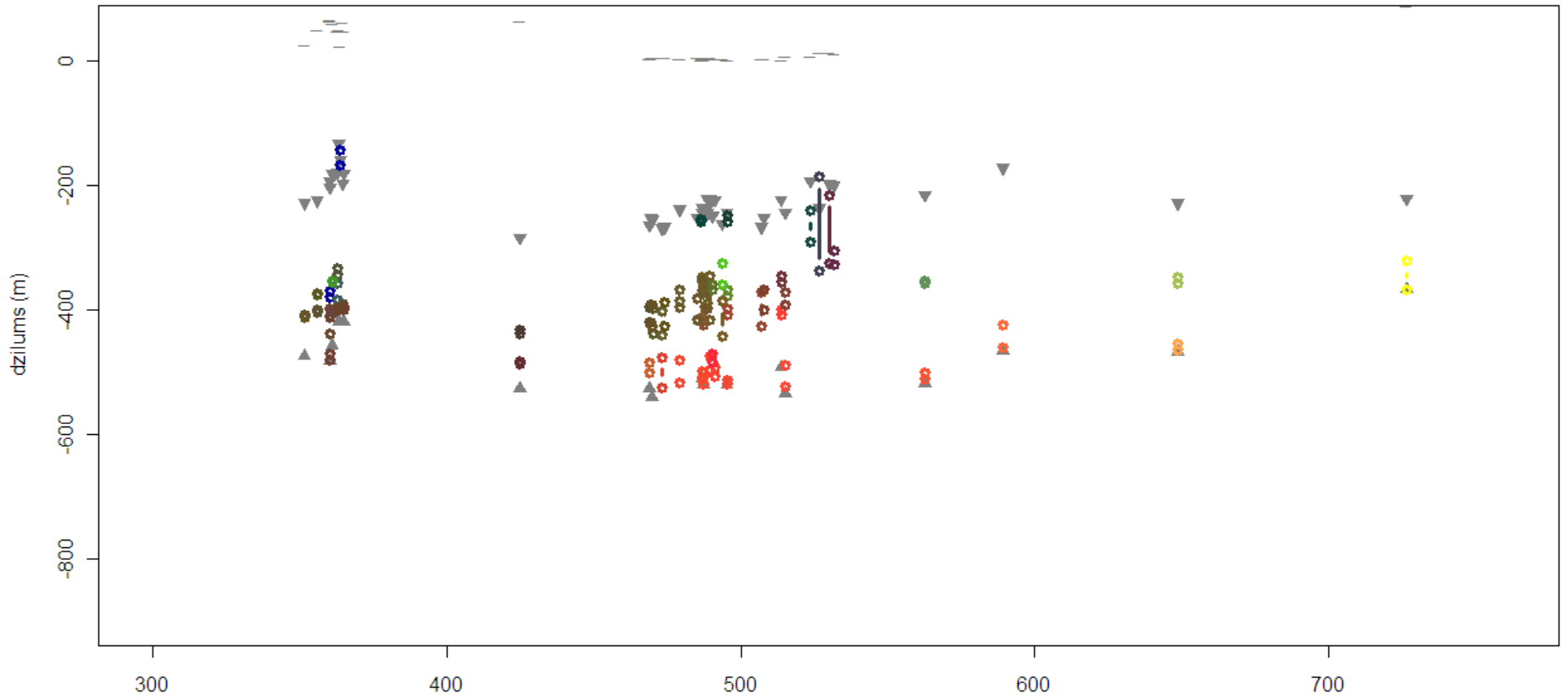
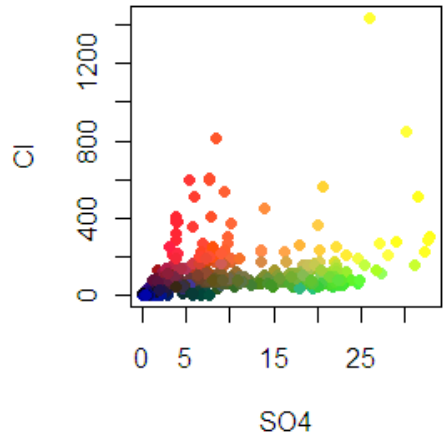
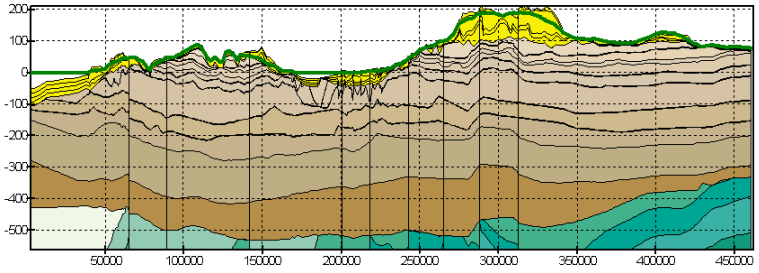
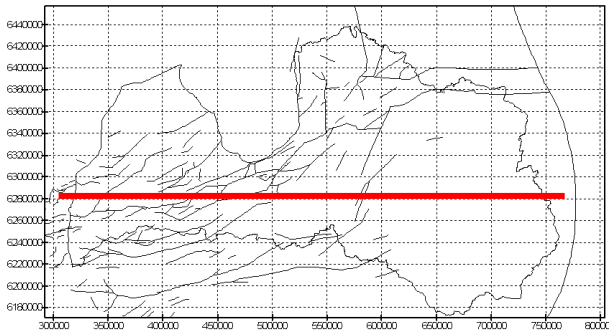
Water composition in cross section









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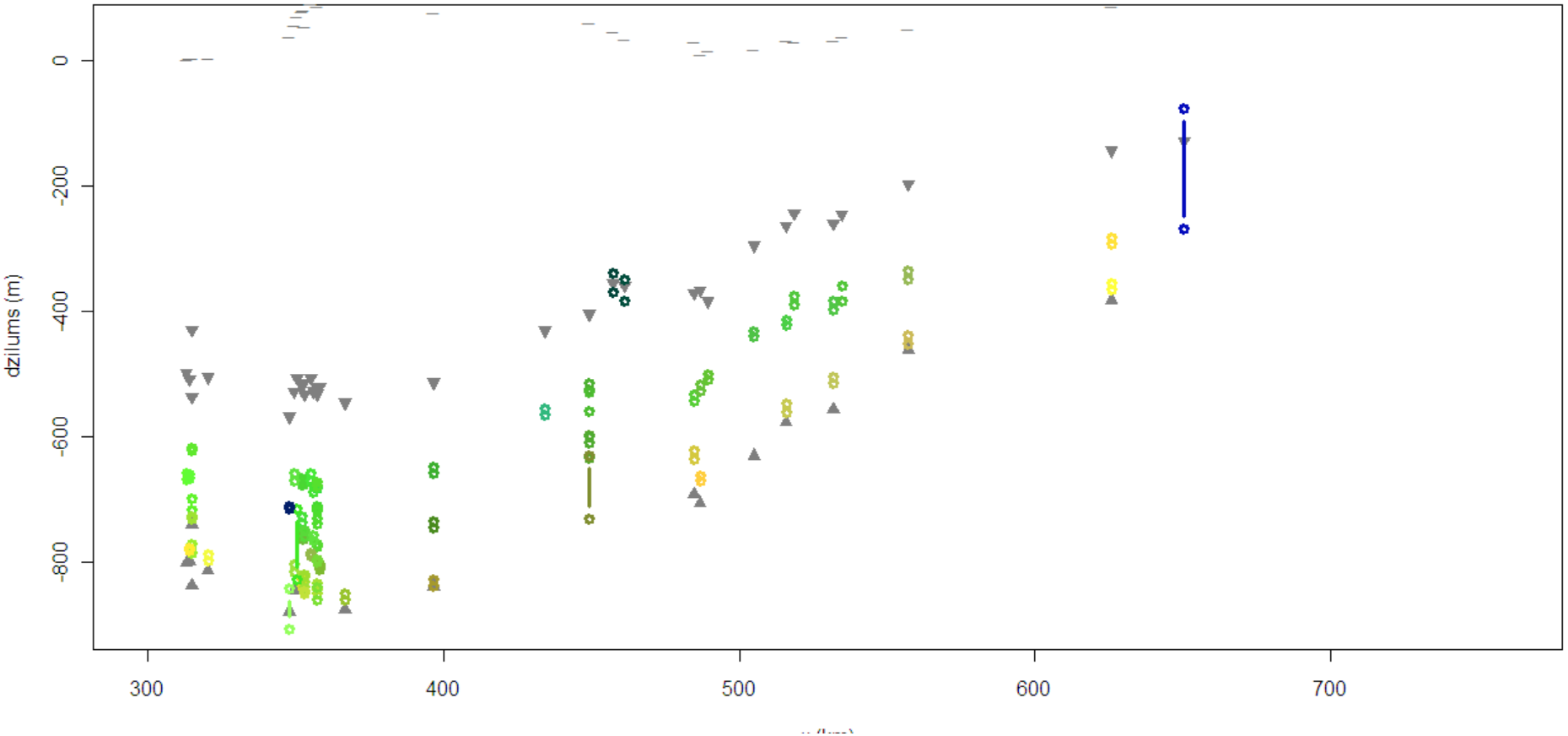

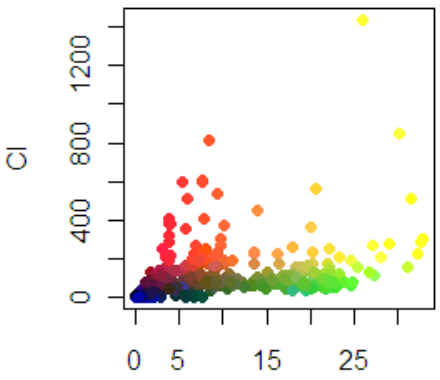

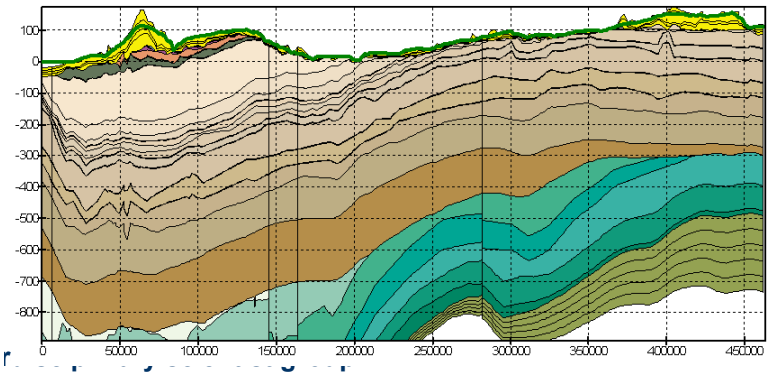

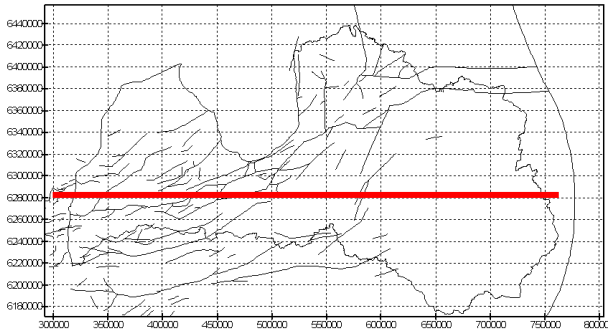

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Conclusions

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Conclusions

- The RGB colour space can be used to show the relative or even absolute concentrations of up to three components
- The lower-middle Devonian aquifer in South-West part of Latvia, from hydro-chemical point of view is a distinct two-horizon system

Time for a glass of wine?

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