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Increase of Arsenic In Production Wells In The Formation of Diest, Belgium

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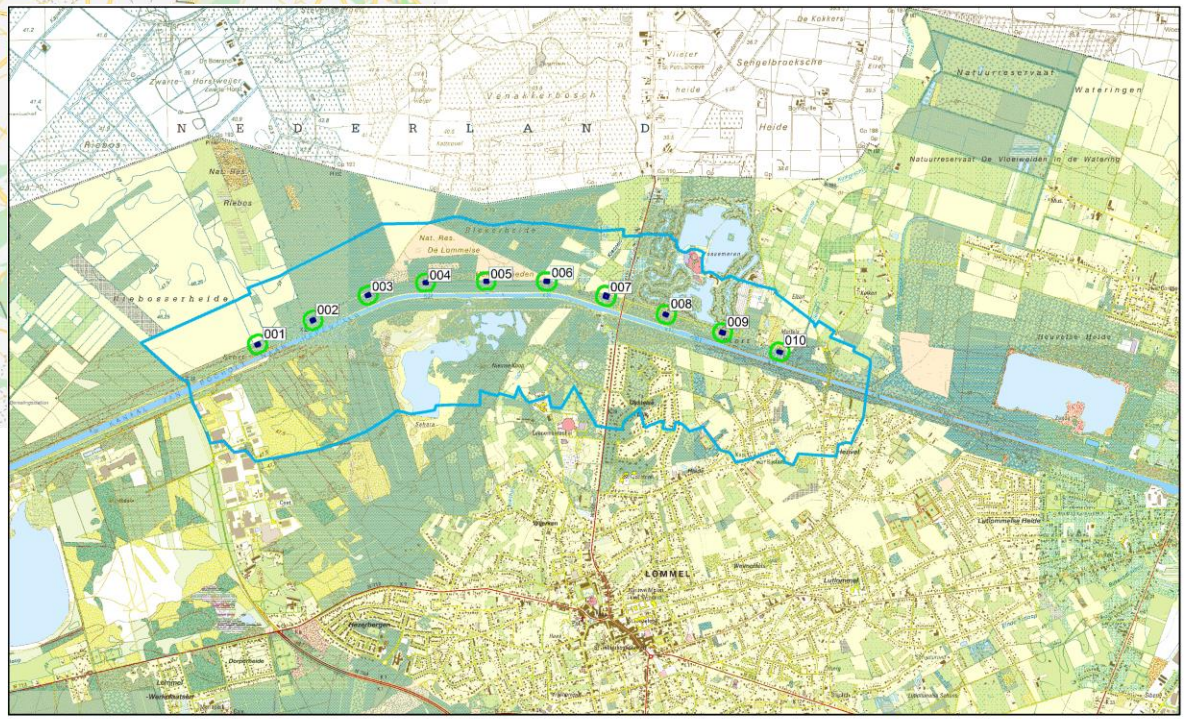
groundwater extraction site ‘Lommel’

10 production wells

8 000 000 m³/y - 25 000 m³/d



Topografische kaart rond de winning Lommel

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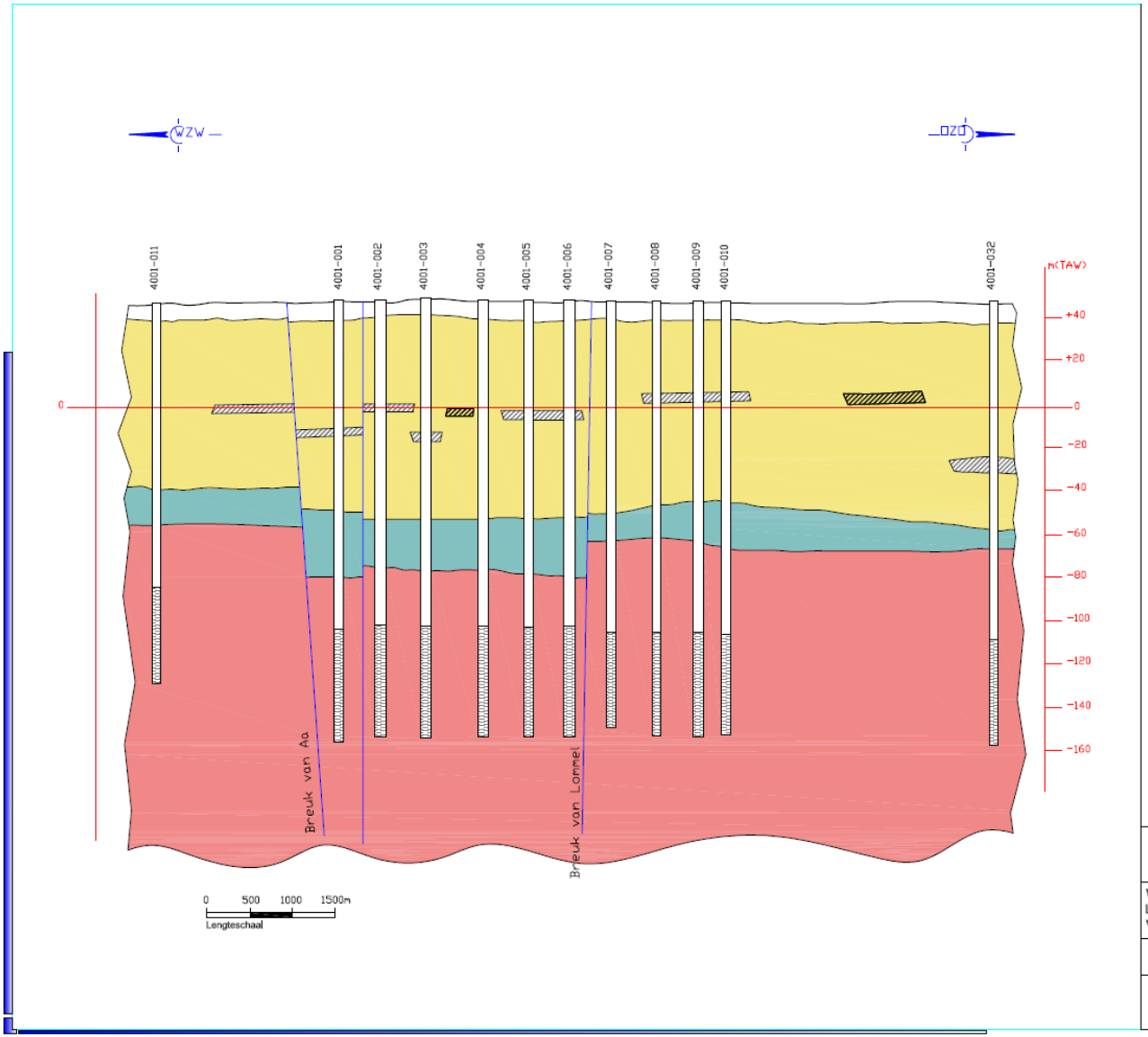
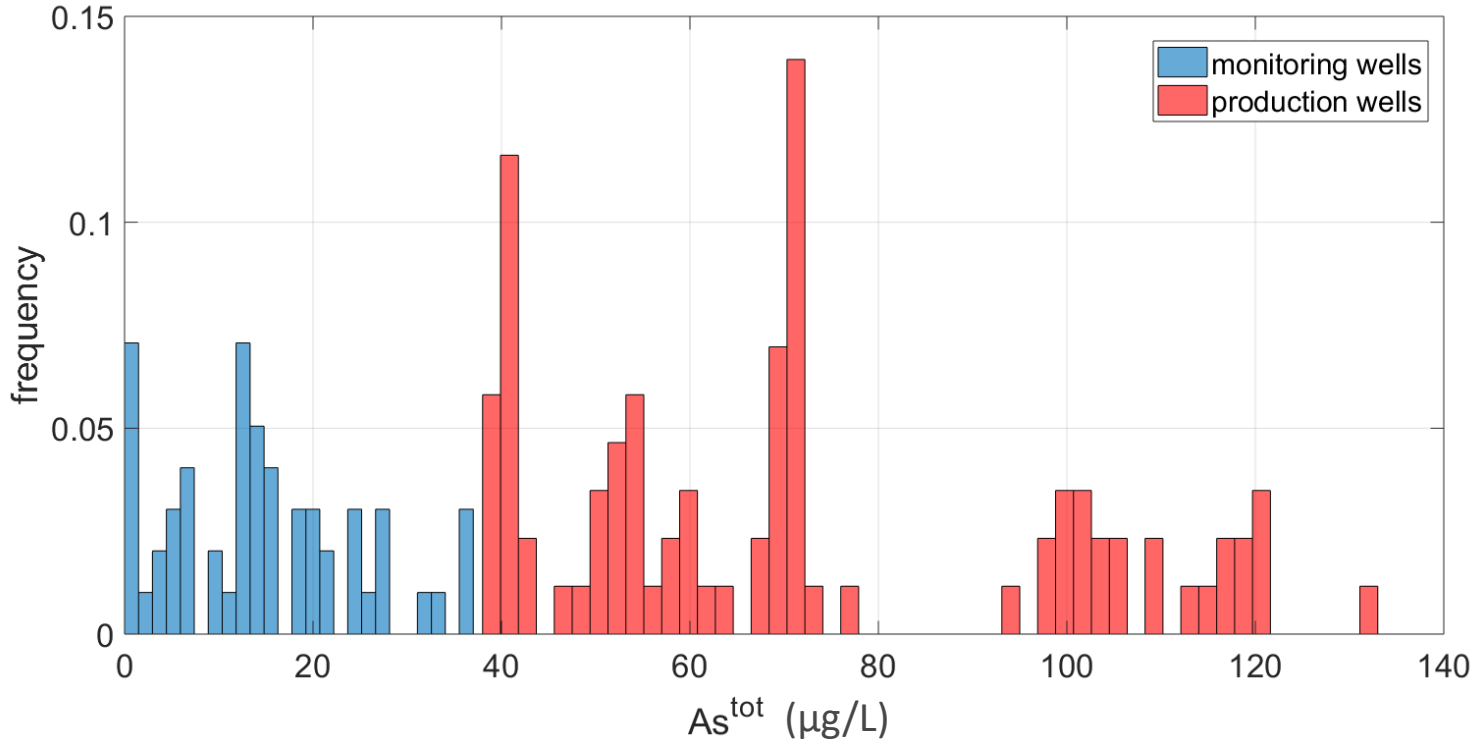
groundwater extraction site ‘Lommel’



Formation of Diest

- Mioceen aquifer
- glauconite bearing sands

groundwater extraction site ‘Lommel’: arsenic



- geochemistry of the Formation of Diest (different arsenic sources …) - well operation screen location - combination of factors - …?
- remediation by well management, … ?

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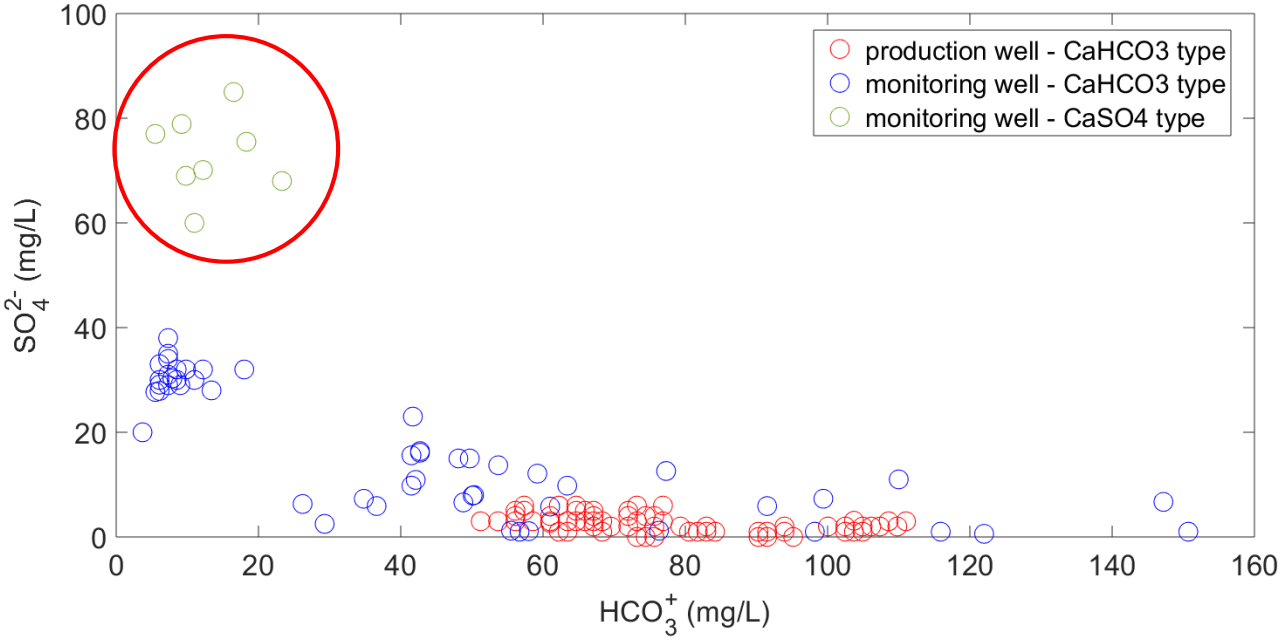
Formation of Diest: water types

Water types – Stuyfzand (1993) classification:

- CaHCO30 and CaSO40 in monitoring wells
- CaHCO30 in production wells



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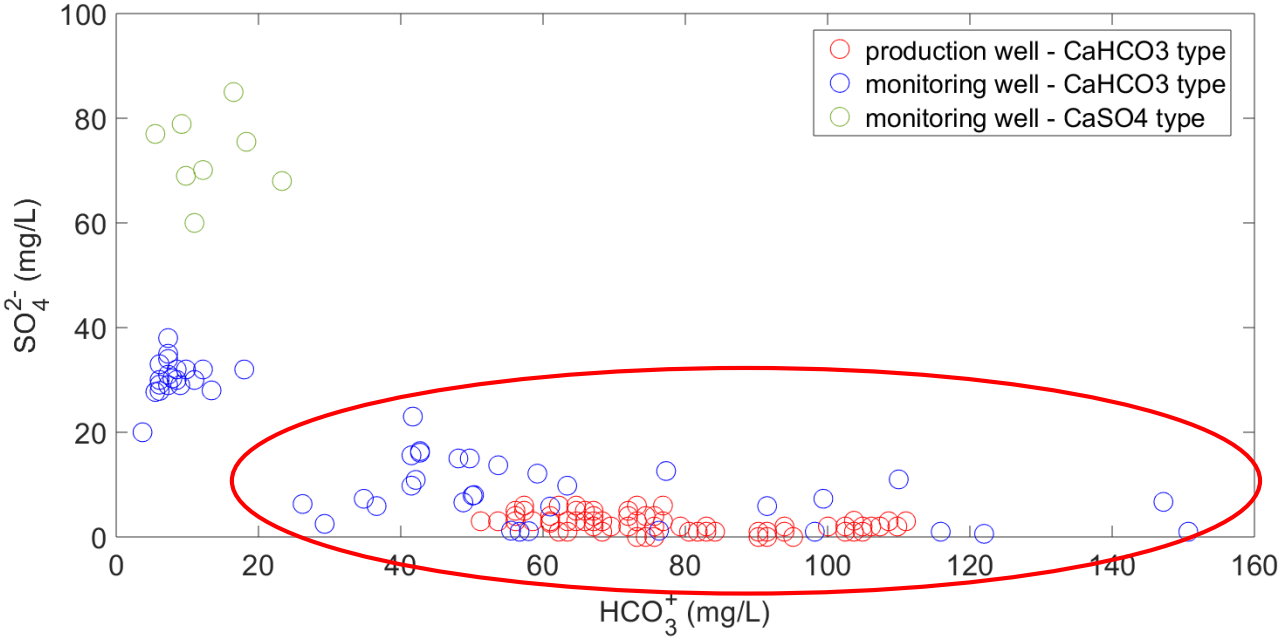

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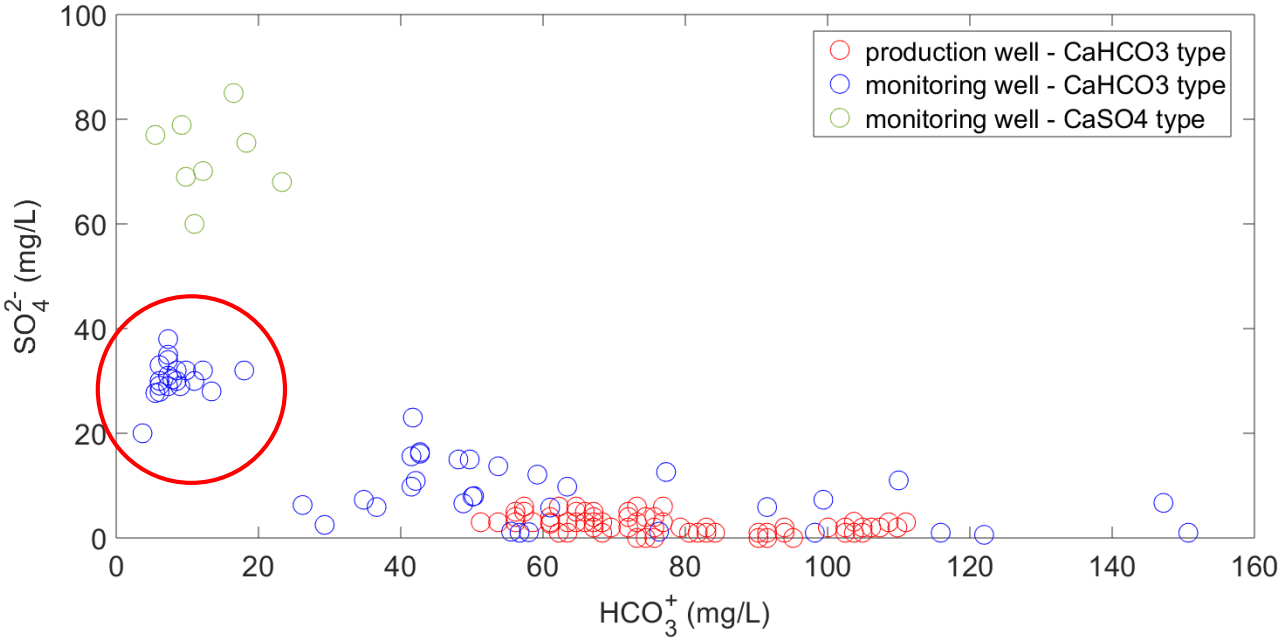

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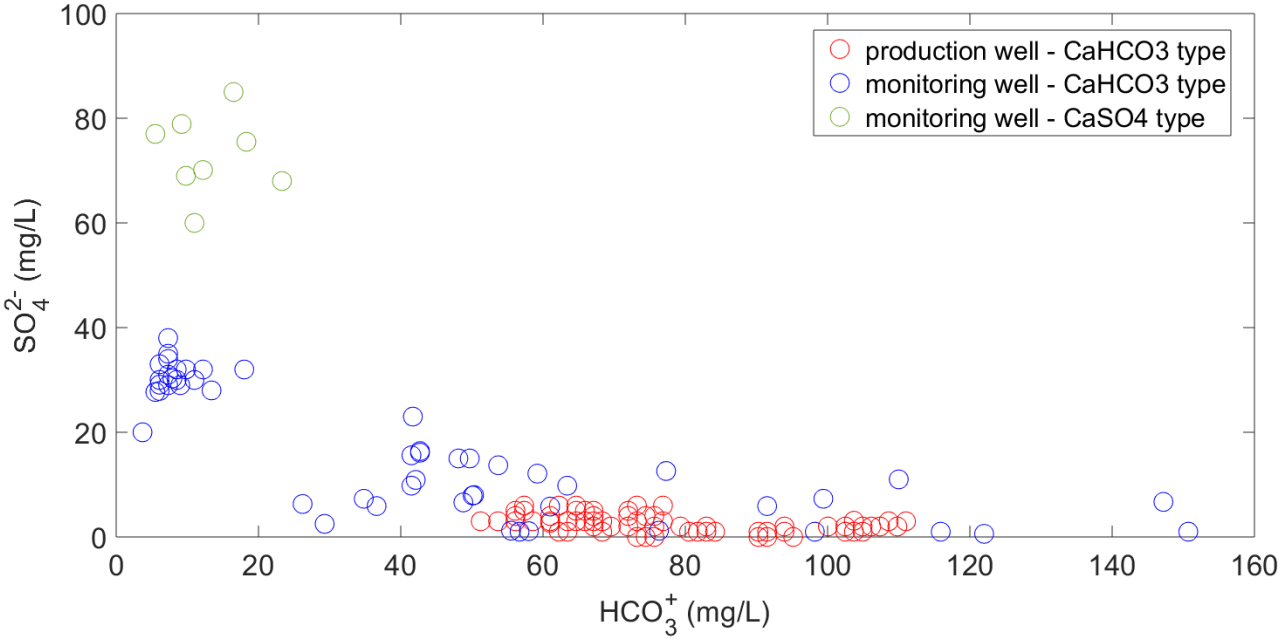

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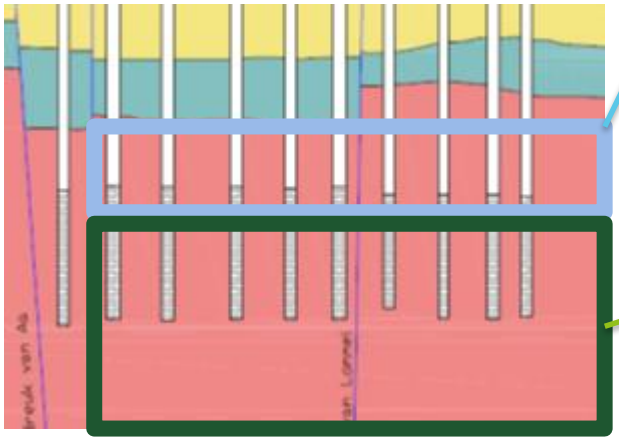
Formation of Diest and water types: a closer look



Diest sands

- glauconite bearing coarse sand
- no carbonate minerals or (micro)fossils
- CaSO4 water
- iron to sulphate reducing

Dessel sands

- glauconite bearing fine sand
- carbonate minerals: calcite, siderite, aragonite
  shell fragments, microfossils
- CaHCO3 water
- sulphate reducing

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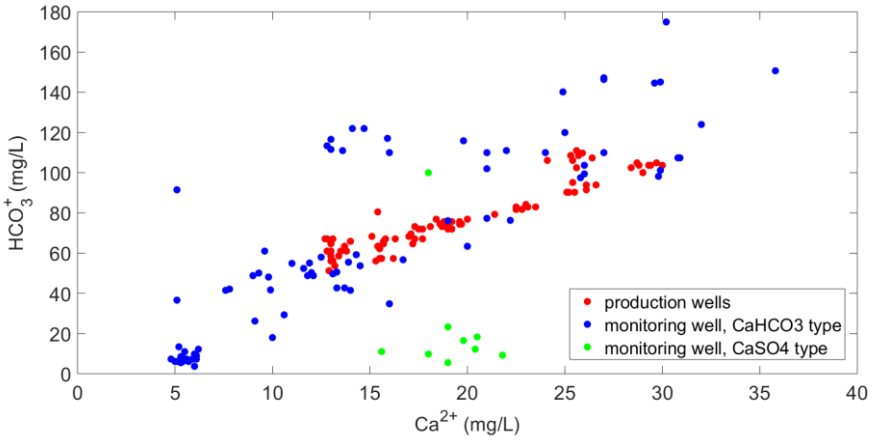
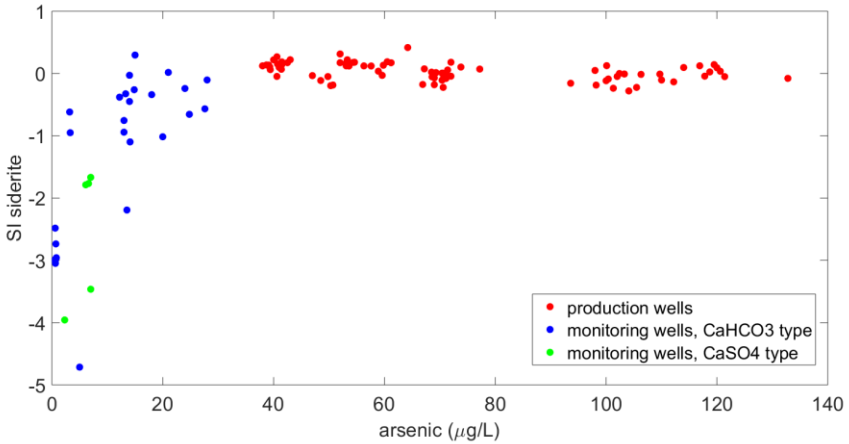
Formation of Diest and water types: a closer look



	SI $CaSO_4$ water	SI $CaHCO_3$ water
calcite	-2 à -5	-0.2 à -1.6
siderite	-2 à -6	0.5 à -0.5
goethite	0 à -3.4	-0.2 à -0.8
hematite	2 à -5	0.5 à 1.6



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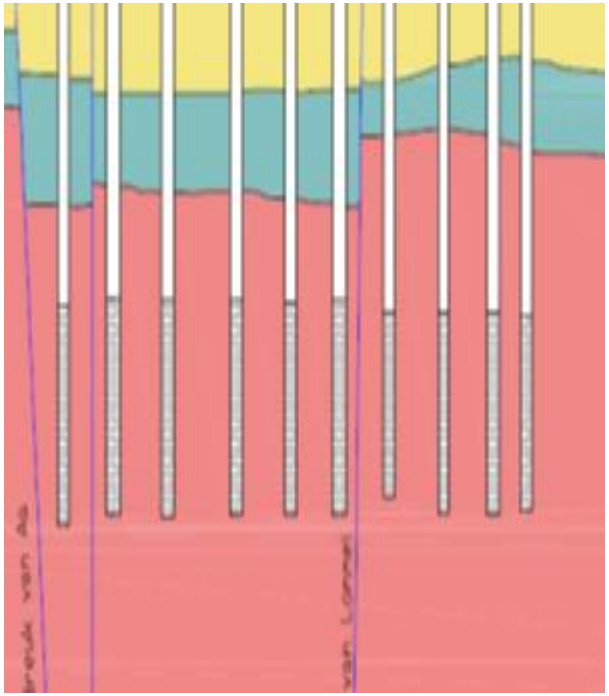
conceptual model for the increase of arsenic



Diest sands

CaSO4 water, undersaturated for calcite, siderite, …

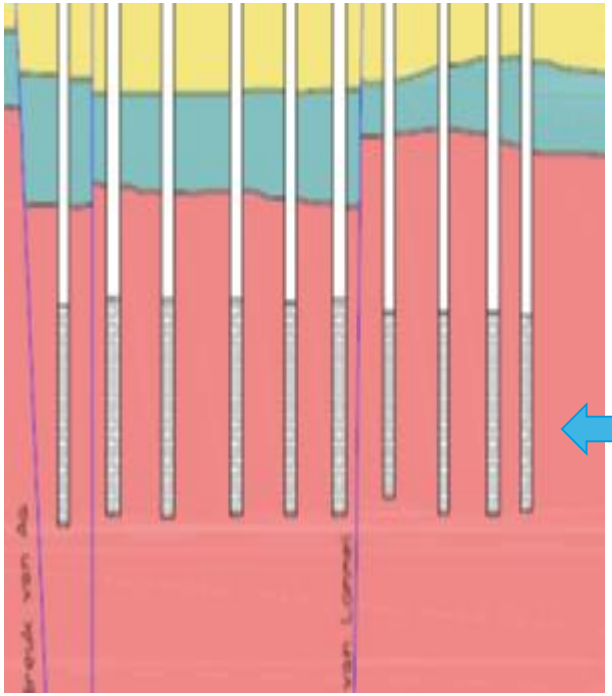
sediments contain no carbonates

Dessel sands

CaHCO3 water, saturated for calcite, siderite, …

sediments contain carbonates

conceptual model for the increase of arsenic



Diest sands

Dessel sands

dissolution of carbonates
- calcite
- siderite

arsenic is adsorbed on ironoxyhydroxides occuring at the surface of siderite

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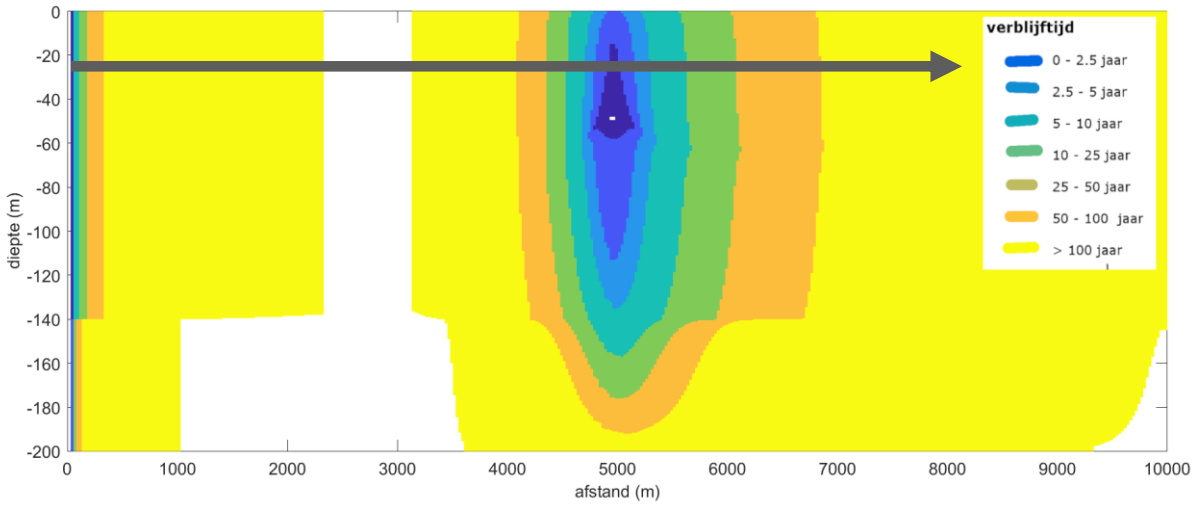
some calculations

flow model



extracted water

- 16% from Diest sands
- 84% from Dessel sands

phreeqC calculations

CaSO4 water equilibrated with calcite and siderite

- 2.3 E-4 mol siderite dissolves to equilibrate 1 l of water
- based on isothermes (Hajji et al, 2019), this gives arsenic concentrations in the observed range

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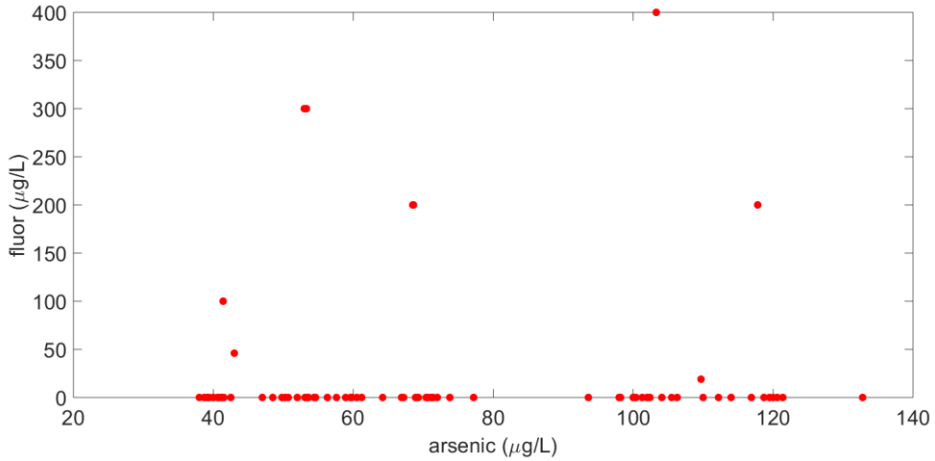
other explanation?

- **glauconite in sediments**
  - occurs in both Dessel and Diesel sands
  - process to disturbe equilibrium?

- **fluorapatiet in Dessel sands**
  - no relation between fluor and arsenic



other explaniation?

- **glauconite in sediments**
  - occurs in both Dessel and Diesel sands
  - difference with monitoring wells?

- **fluorapatite in Dessel sands**
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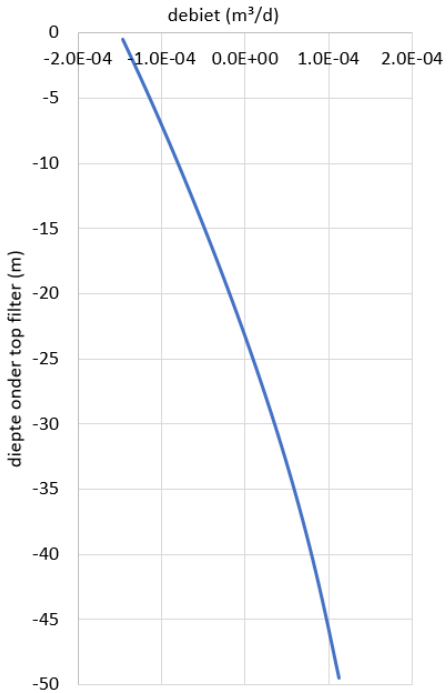
- **well management**
  - frequent stand-stills
  - exchange of water is small



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  - frequent stand-stills
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- **local horizons with higher arsenic**

- **…**

conclusion

- high arsenic concentrations in production wells are most probably related to leakage of water from above the screen level
- dissolution of siderite could increase arsenic
- increase is clearly due to the extraction – hence the difference with monitoring wells
- importance of having monitoring wells besides checking groundwater quality in production wells
- an issue that can not be resolved by well management, only by positioning extraction well screens in a clever way