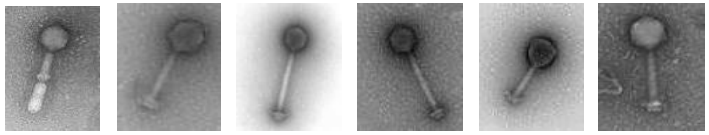
HelmholtzZentrum münchen
German Research Center for Environmental Health



Li Deng & Christian Griebler

Diversity and functionality of groundwater viral communities

Institute of Groundwater Ecology

HELMHOLTZ ASSOCIATION

Why study viruses?

Freshwater Biology (2009) **54,** 649–677

Microbial biodiversity in groundwater ecosystems

C. GRIEBLER AND T. LUEDERS
Helmholtz Zentrum München – German Research Center for Environmental Health, Institute of Groundwater Ecology, Neuherberg, Germany

"The greatest diversity of living organisms on our planet is found within the microbes. They are ubiquitous and abundant. Invisible to the human eye, microbes are generally responsible for processes of global relevance and the turnover of energy and matter."

Viruses: globally important player

1. Small and abundant - 20-200 nm, 10^{31} tailed phages, 10:1 VBR

Breitbart et al.,2007; Danovaro, 2008; Fuhrman et al., 1993, 1999, 2000; Mann et al, 2003; Lindell et al., 2004,2005,2007; Sharon et al., 2007;Sullivan et al.,2005,2006; Suttle 2005,2008; Williamson et al., 2008.

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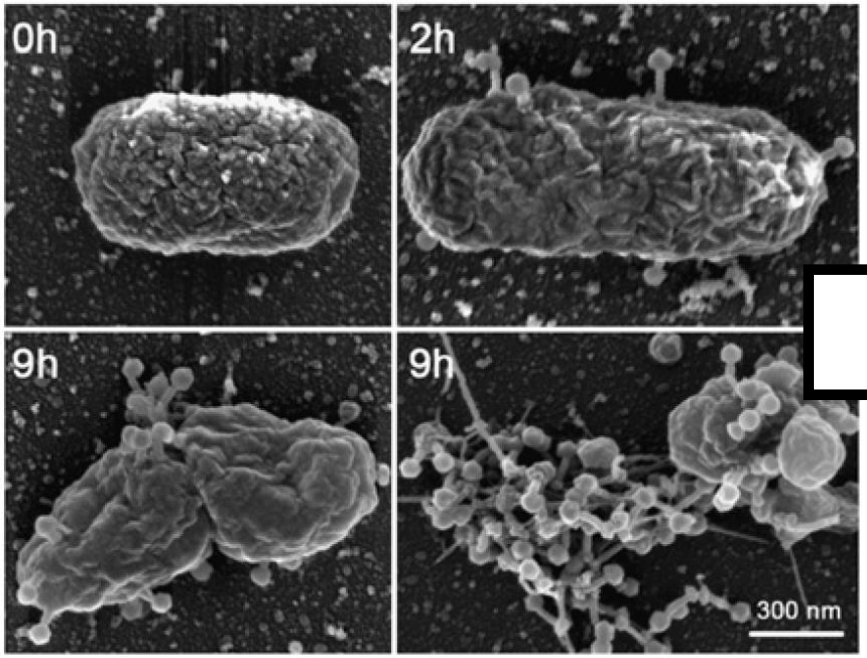

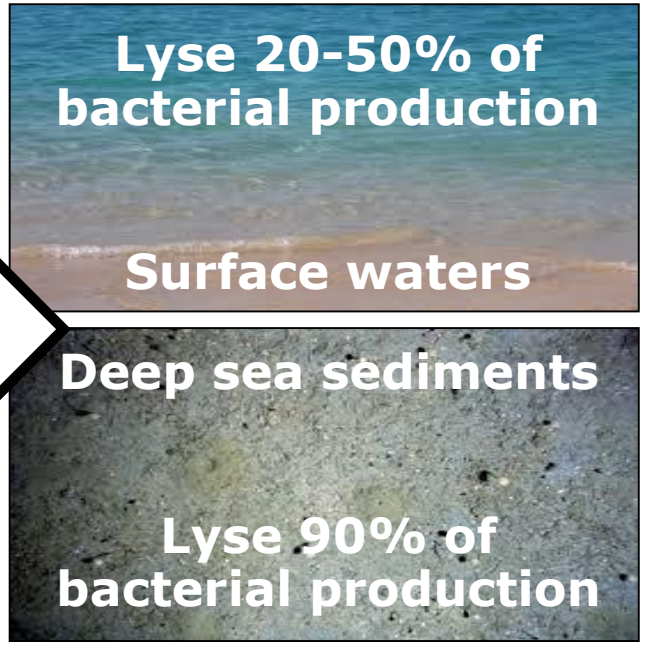

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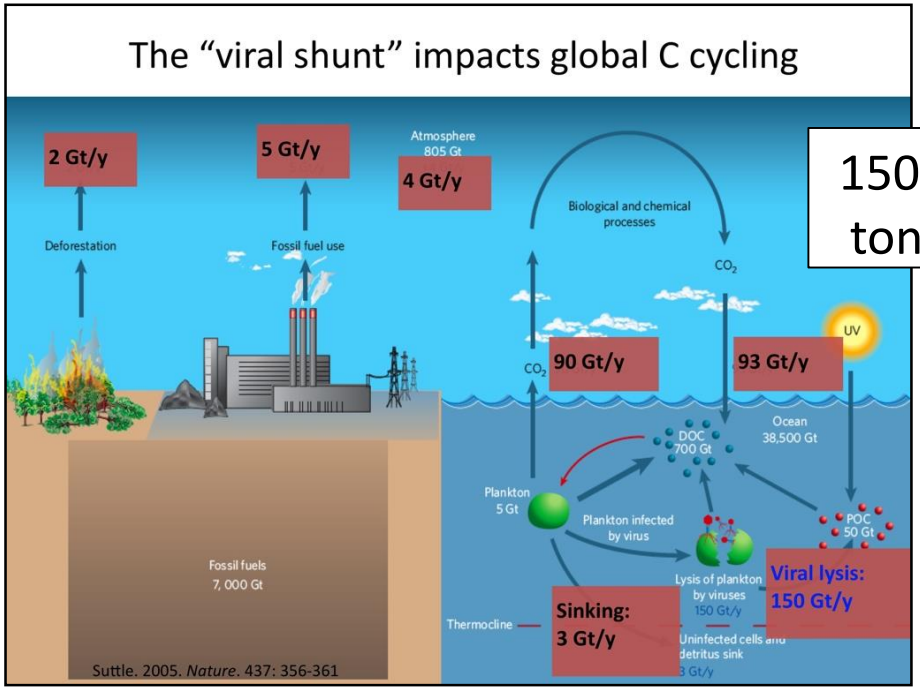
3. They recycle carbon and nutrients – viral shunt



150 Billion tones yr^{-1}

Breitbart et al.,2007; Danovaro, 2008; Fuhrman et al., 1993, 1999, 2000; Mann et al, 2003; Lindell et al., 2004,2005,2007; Sharon et al., 2007;Sullivan et al.,2005,2006; Suttle 2005,2008; Williamson et al., 2008.

Viruses: globally important player

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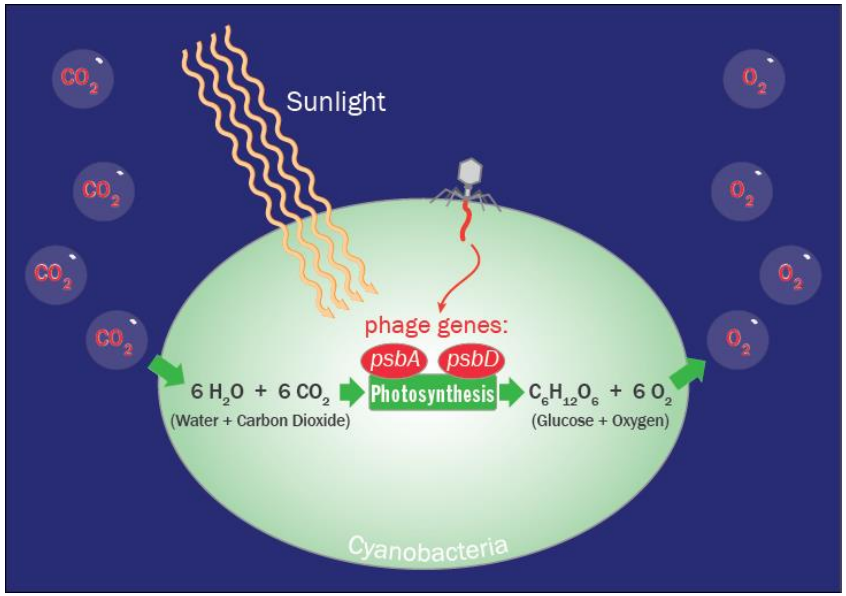
4. Viruses carry and make use of host genetic information

- Core photosynthesis genes are found in viral genomes, "used" during infection
- 'Viral' version of phosphate stress, nitrogen fixation, sulfur oxidation, vitamin biosynthesis, antibiotic resistance genes ...



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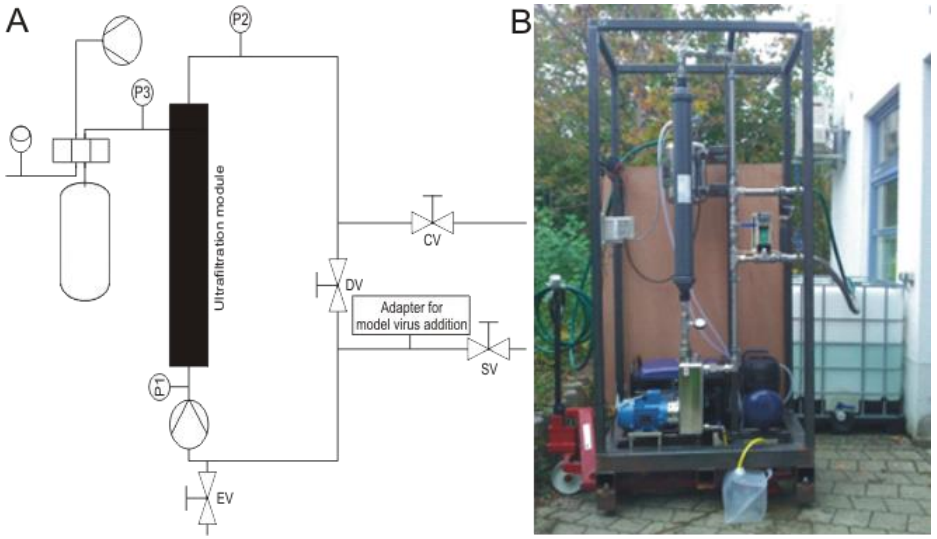
How do we study viruses in groundwater?

Collection of viral-size particles from groundwater



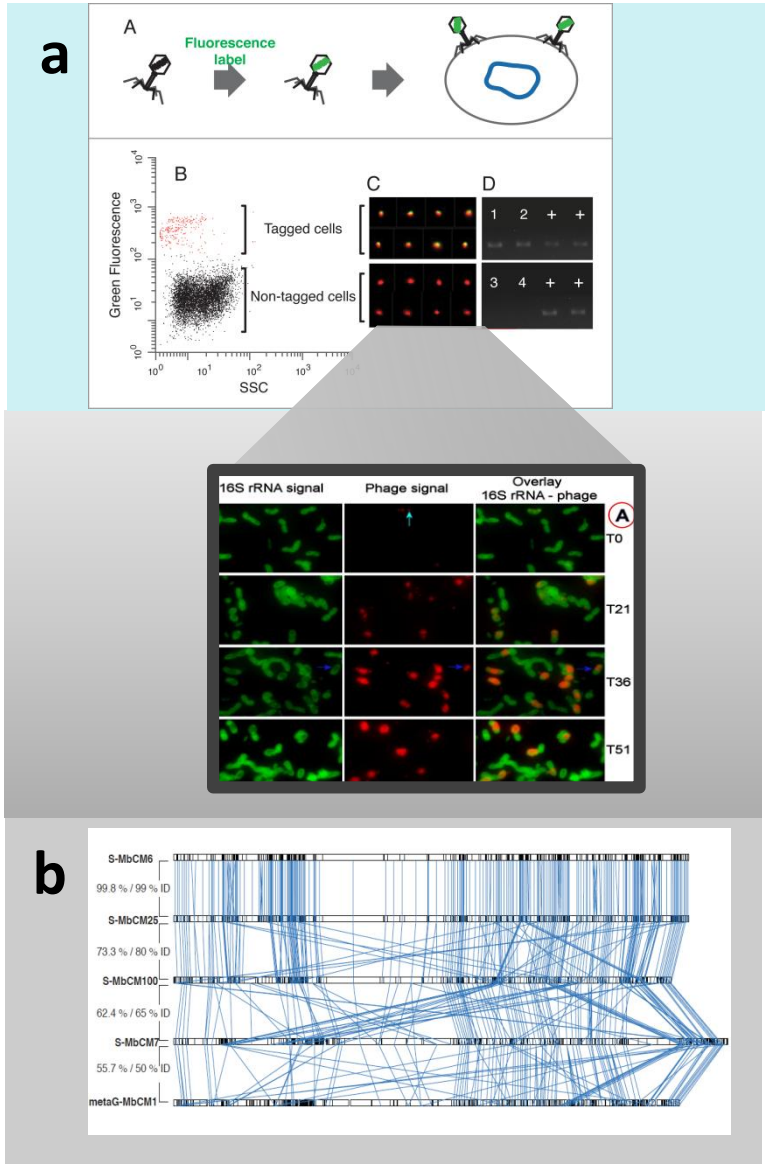
C

monolithic affinity filtration column

Michael Seidel & Co, TUM

- Concentration of viruses from groundwater by either precipitation with iron-chloride or via nanofiltration (few liters to 30 m^3)
- Isolation of both DNA, purification, amplification, and deep sequencing (454 Roche, Illumina, Ion Torrent)

The phage/virus tool box



a. "Viral-Tagging"

- Link of a virus to its host *In situ*
- Keep the host-virus linkage
- Simplify the viral community (for easier assembly) for deep explorations of genes

b. "Viral metagenomics & PC analysis"

- Exploration of viral diversity
- Horizontal gene transfer (HGT)
- Auxilliary metabolic genes (AMG)

Deng et al, ***mBio***,2012; Deng et al, ***Nature***, 2014

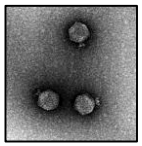
Aim of our research

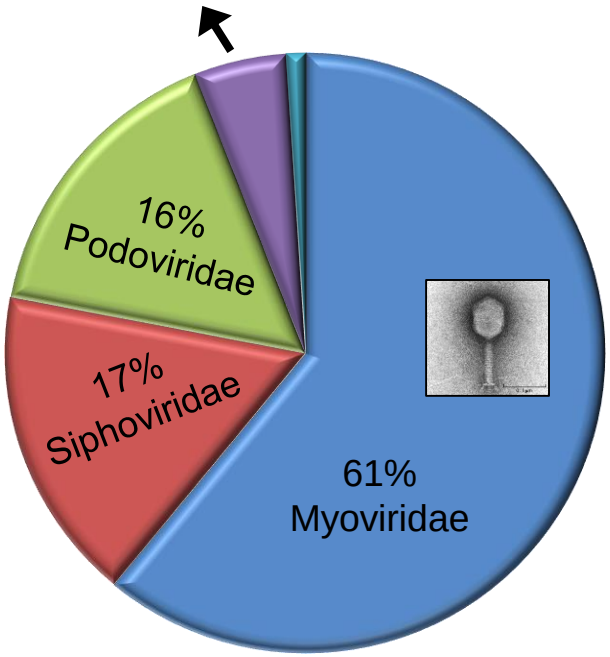
- Shed light to the diversity and role (functions) of viruses in groundwater ecosystems

Non-contaminated, oligotrophic groundwater

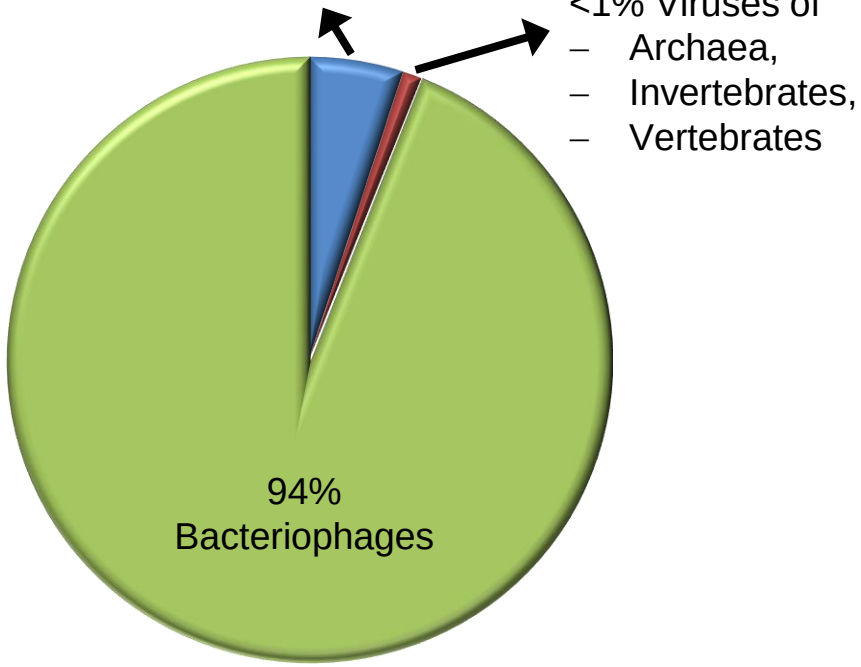
Organically contaminated groundwater

The 1st viral metagenome from oligotrophic groundwater





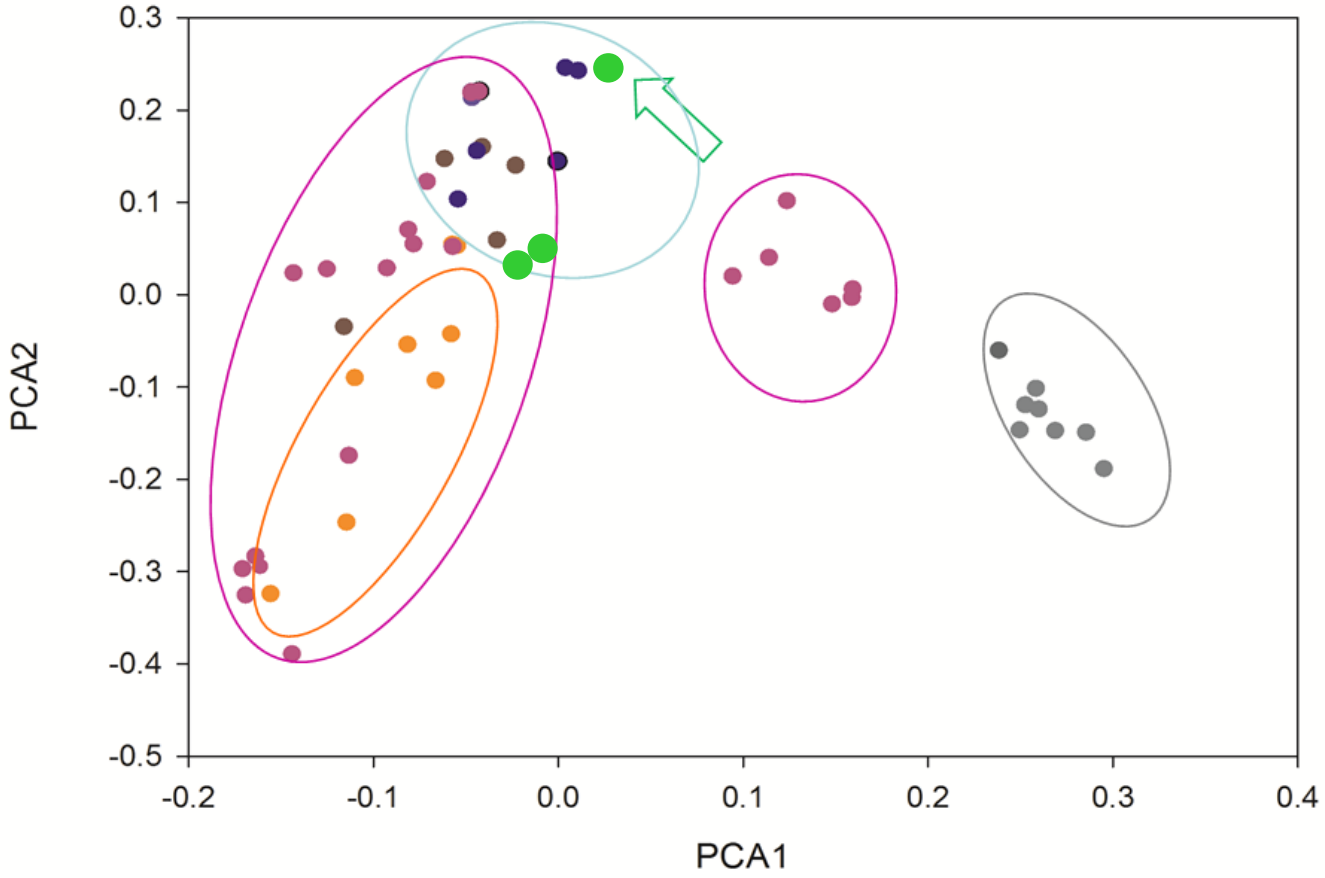
dominated by tailed phages (>94%)



dominated by bacteriophages

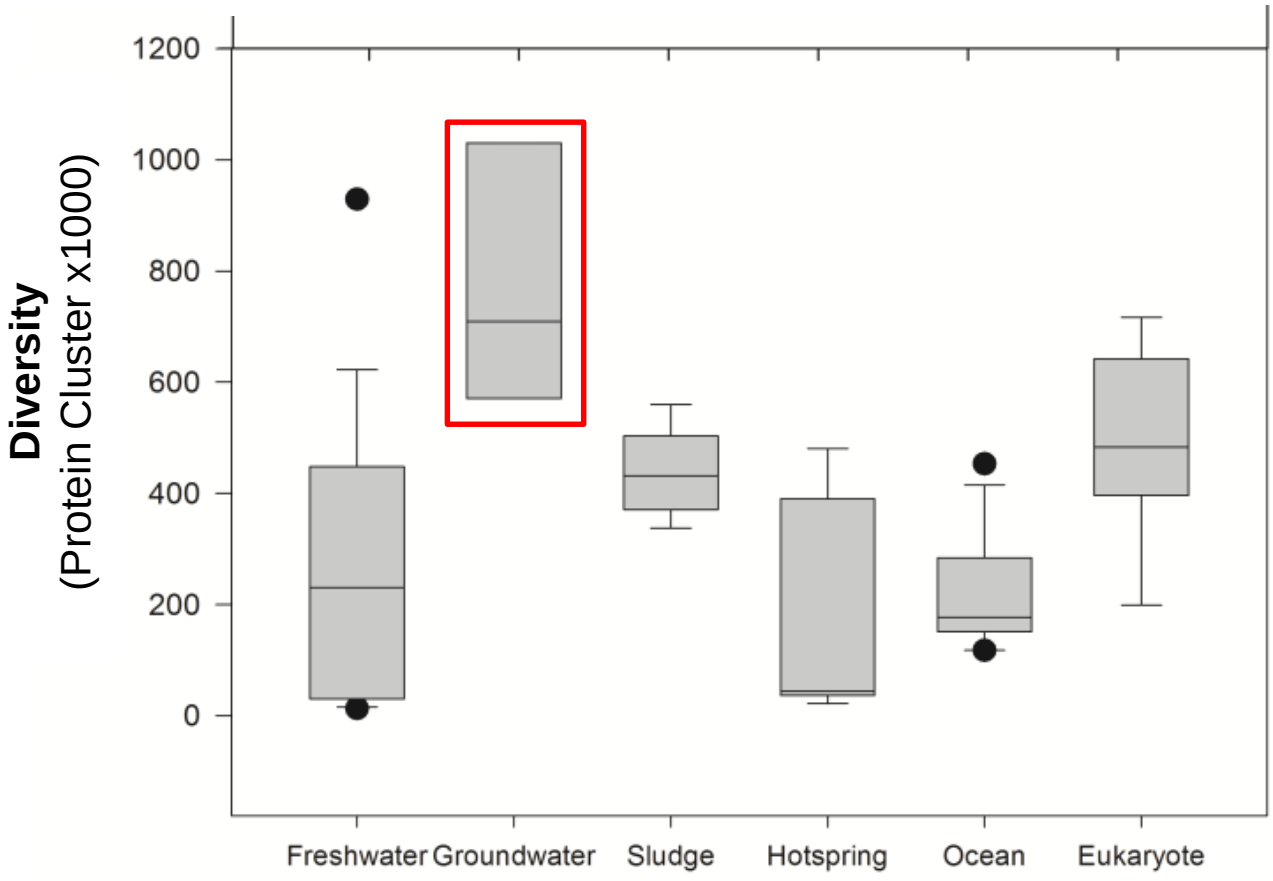
Phage pictures: LookForDiagnosis.com, www.snipview.com, http://www.abovetopsecret.com/forum/thread470839/pg1, http://microbio-insolites-extremes.kazeo.com/,

Viral communities across aquatic habitats



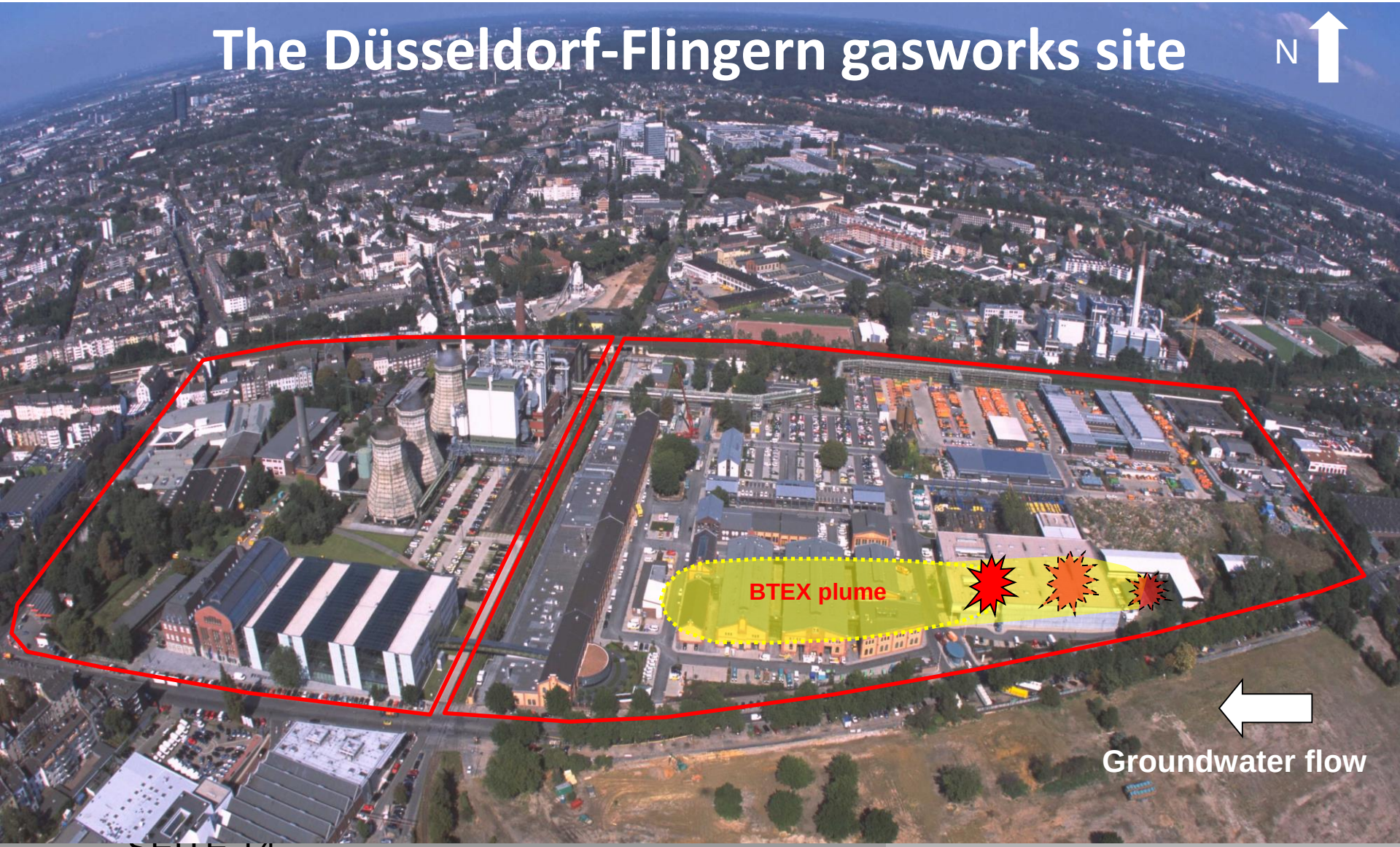
Green: Groundwater
Blue: Freshwater
Brown: Hypersaline wat.
Purple: Marine systems
Orange: Hot springs
Gray: Fish associated in freshwater

Viral communities across aquatic habitats



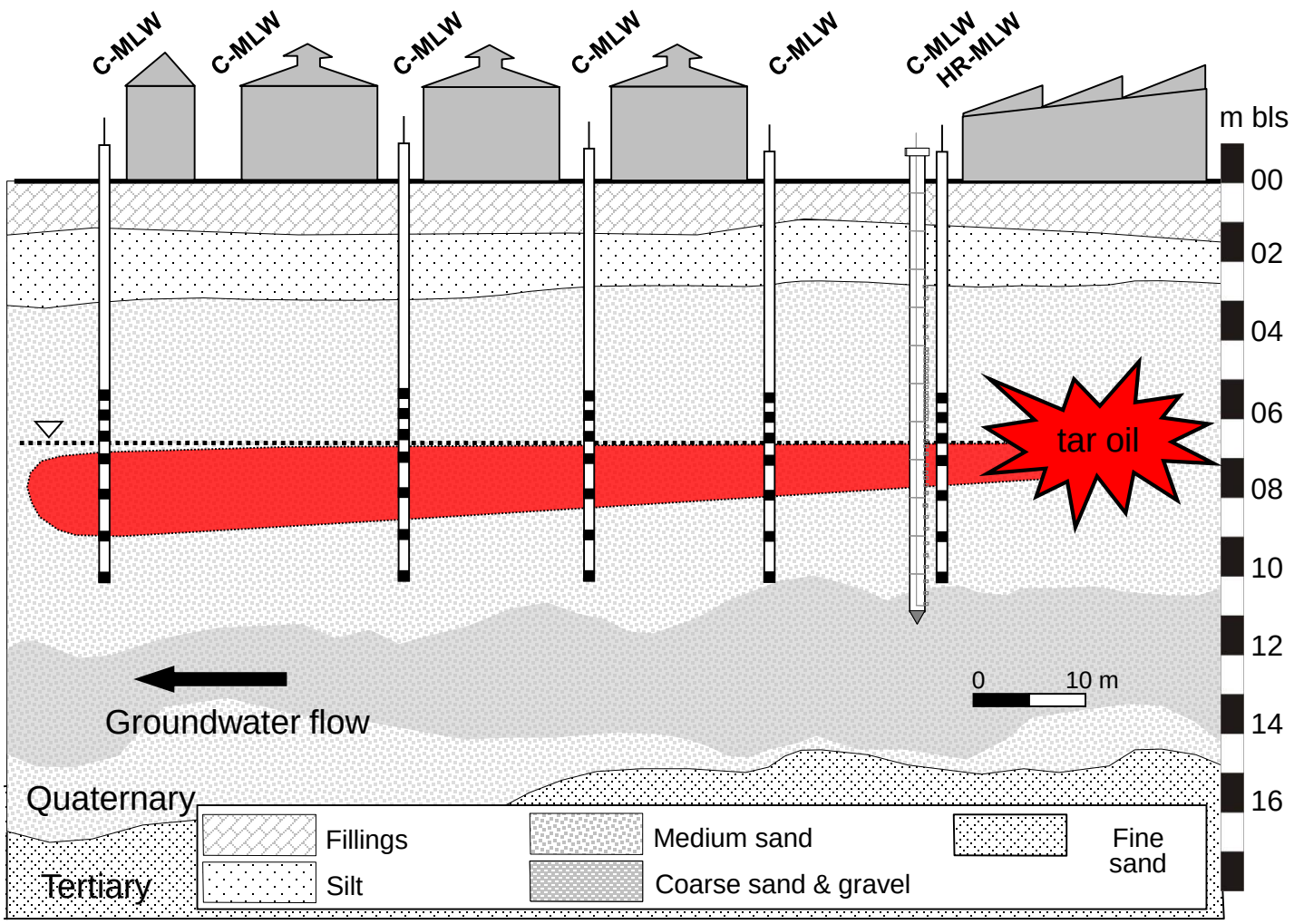
- The cluster richness of each viral assembly, however, was significantly different between each other.
- The highest diversity being observed in our groundwater sample.

Is there different viruses in contaminated groundwater ?



What happened in the Düsseldorf-Flingern aquifer?

2006



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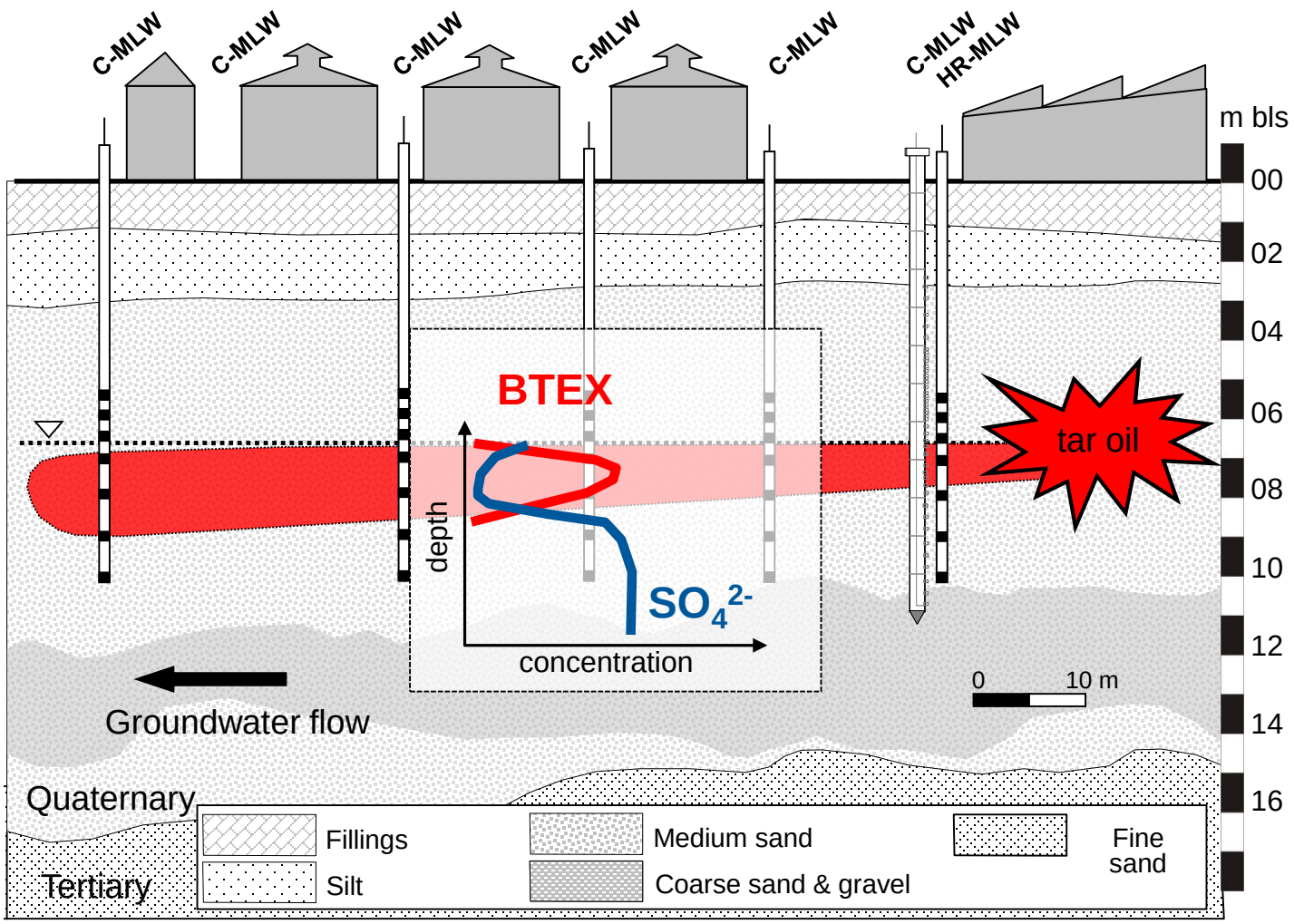

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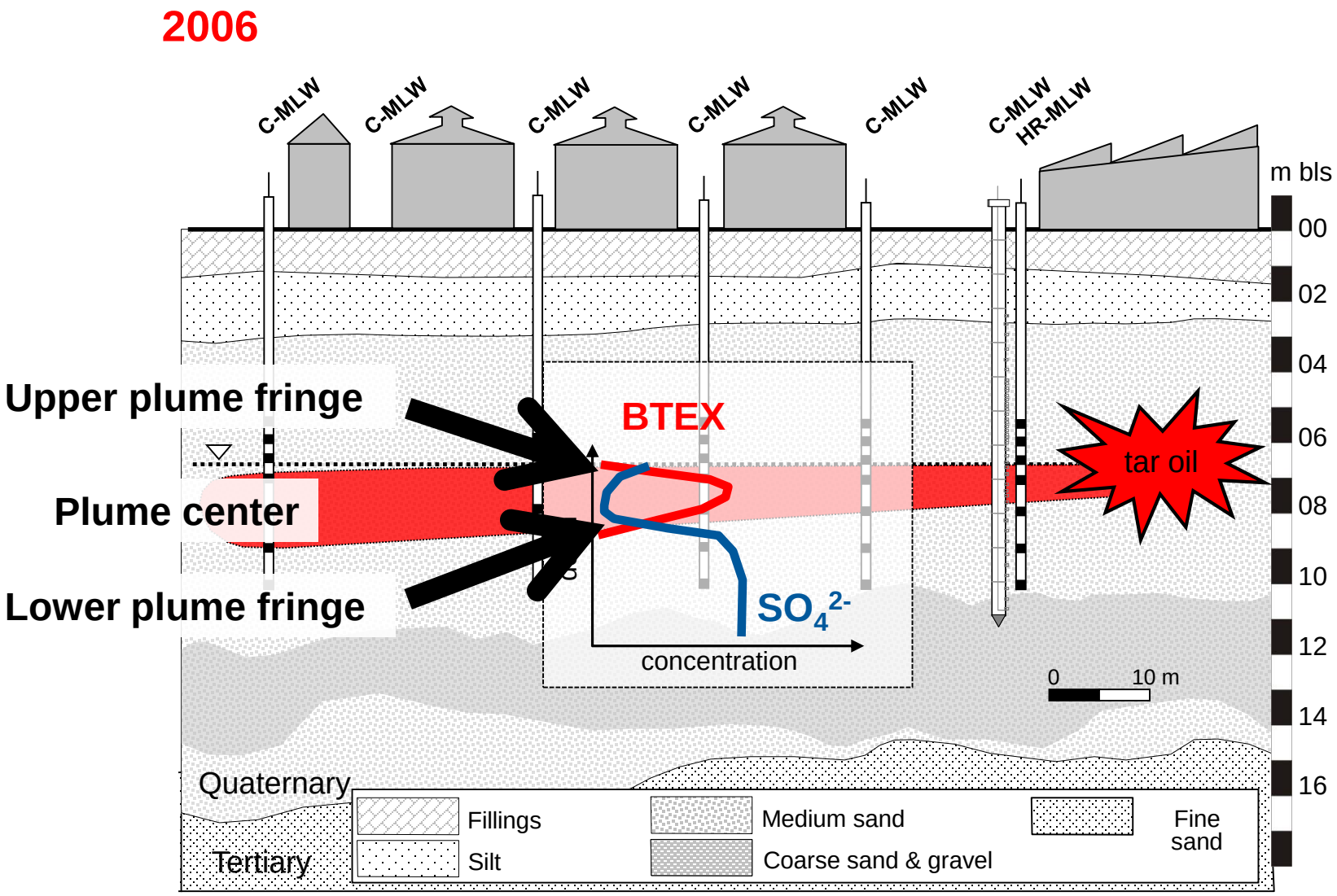
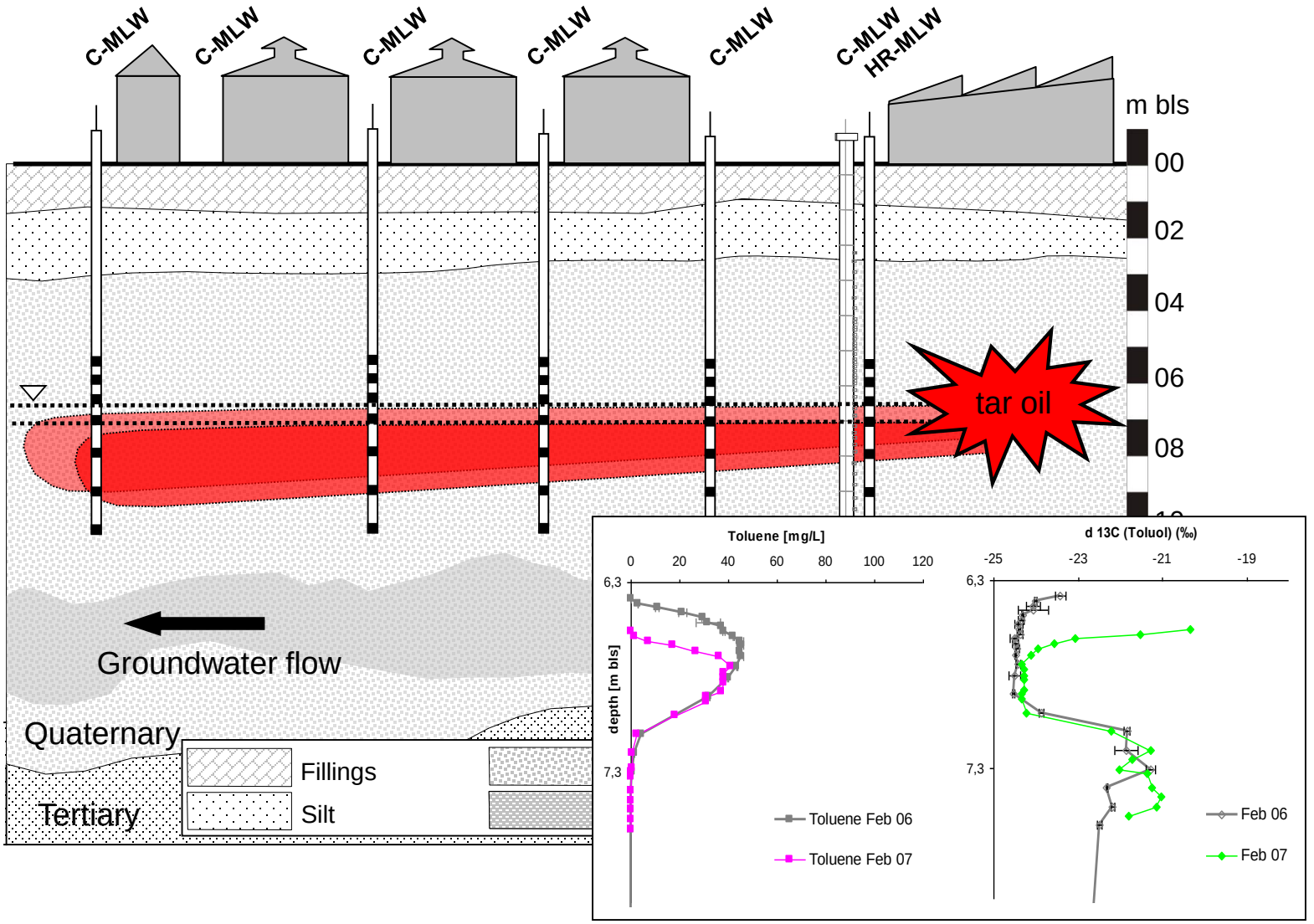


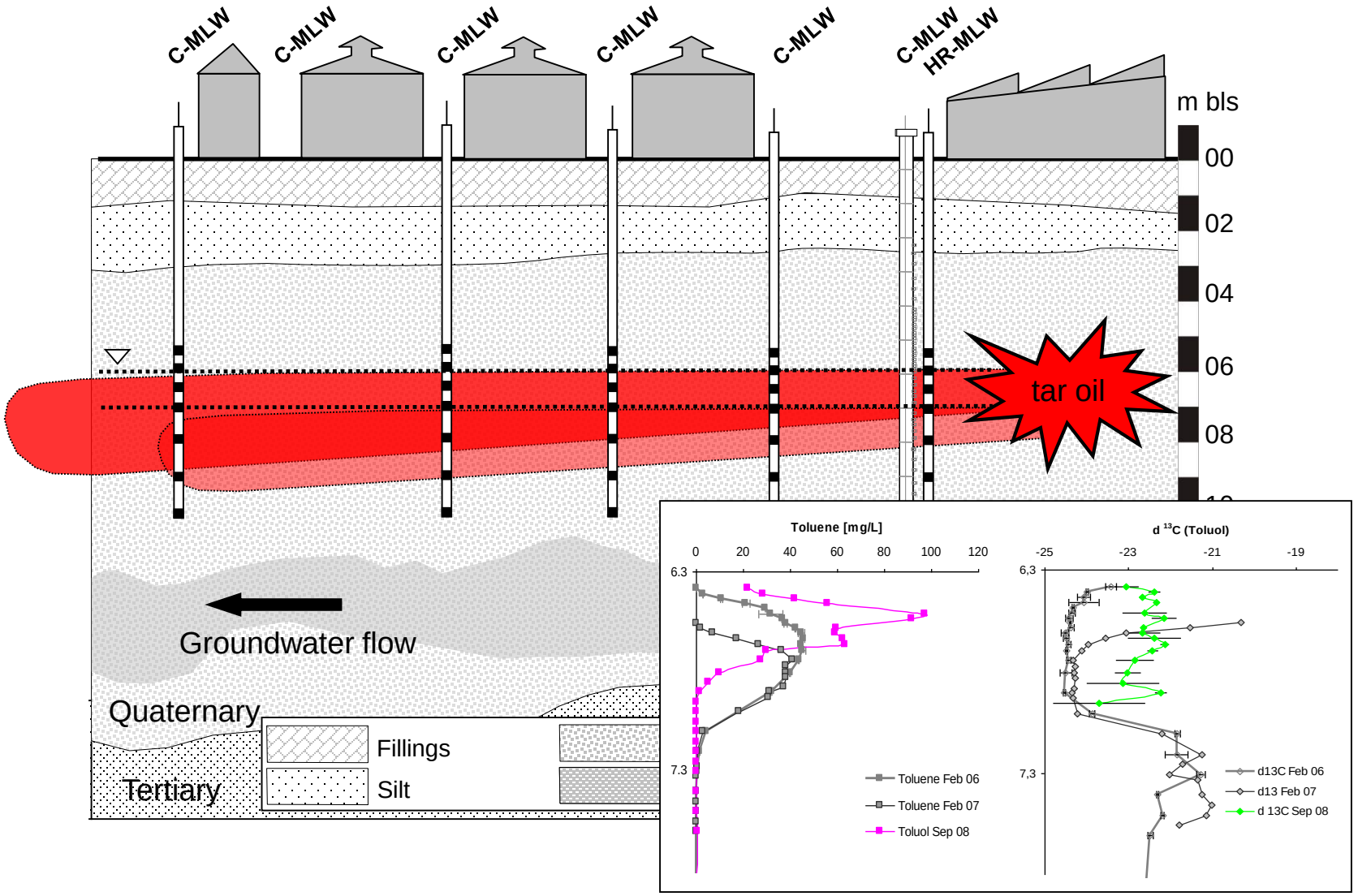
What happened in the Düsseldorf-Flingern aquifer?

2006 to 2007



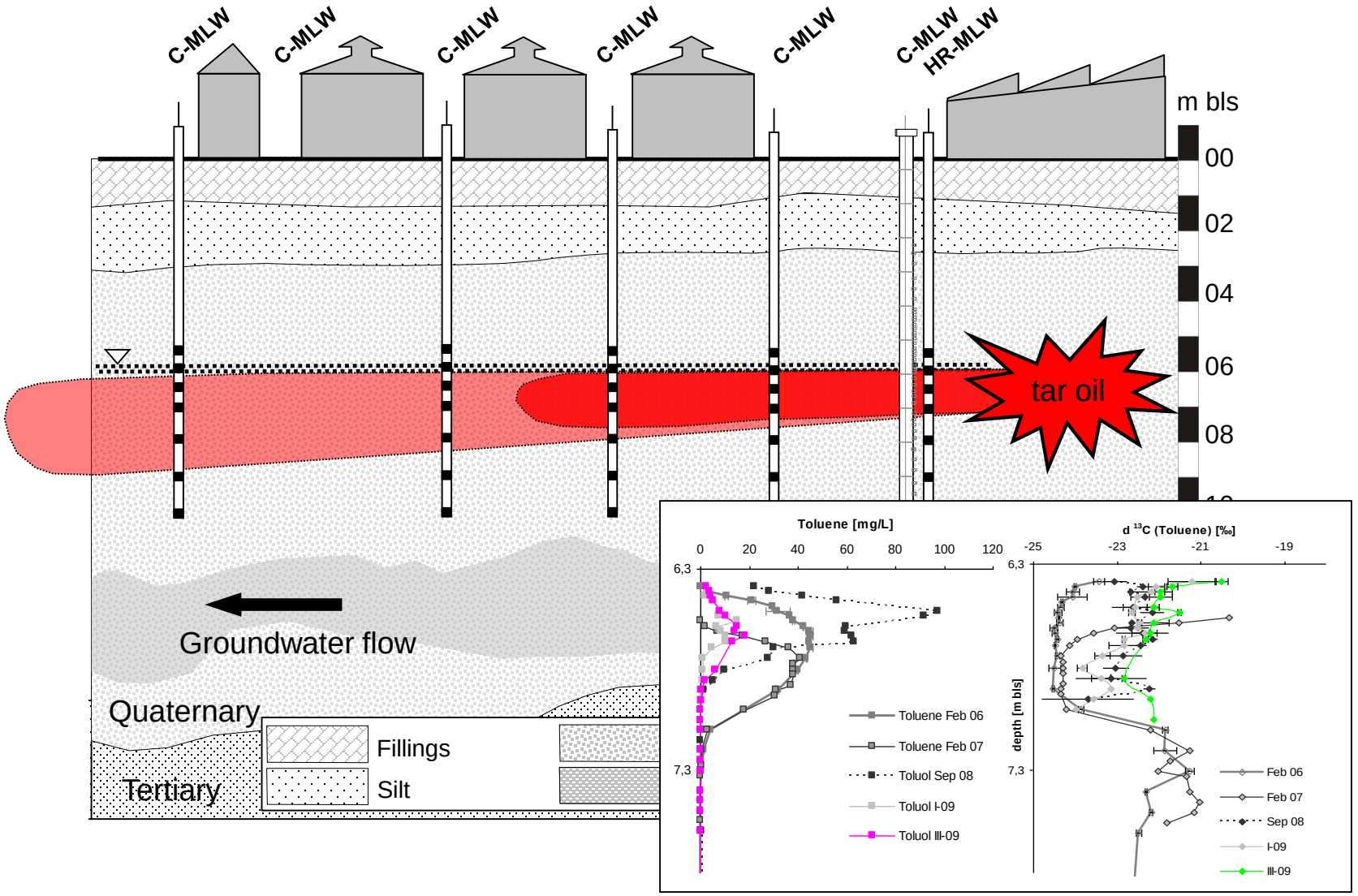
What happened in the Düsseldorf-Flingern aquifer?

2007 to 2008

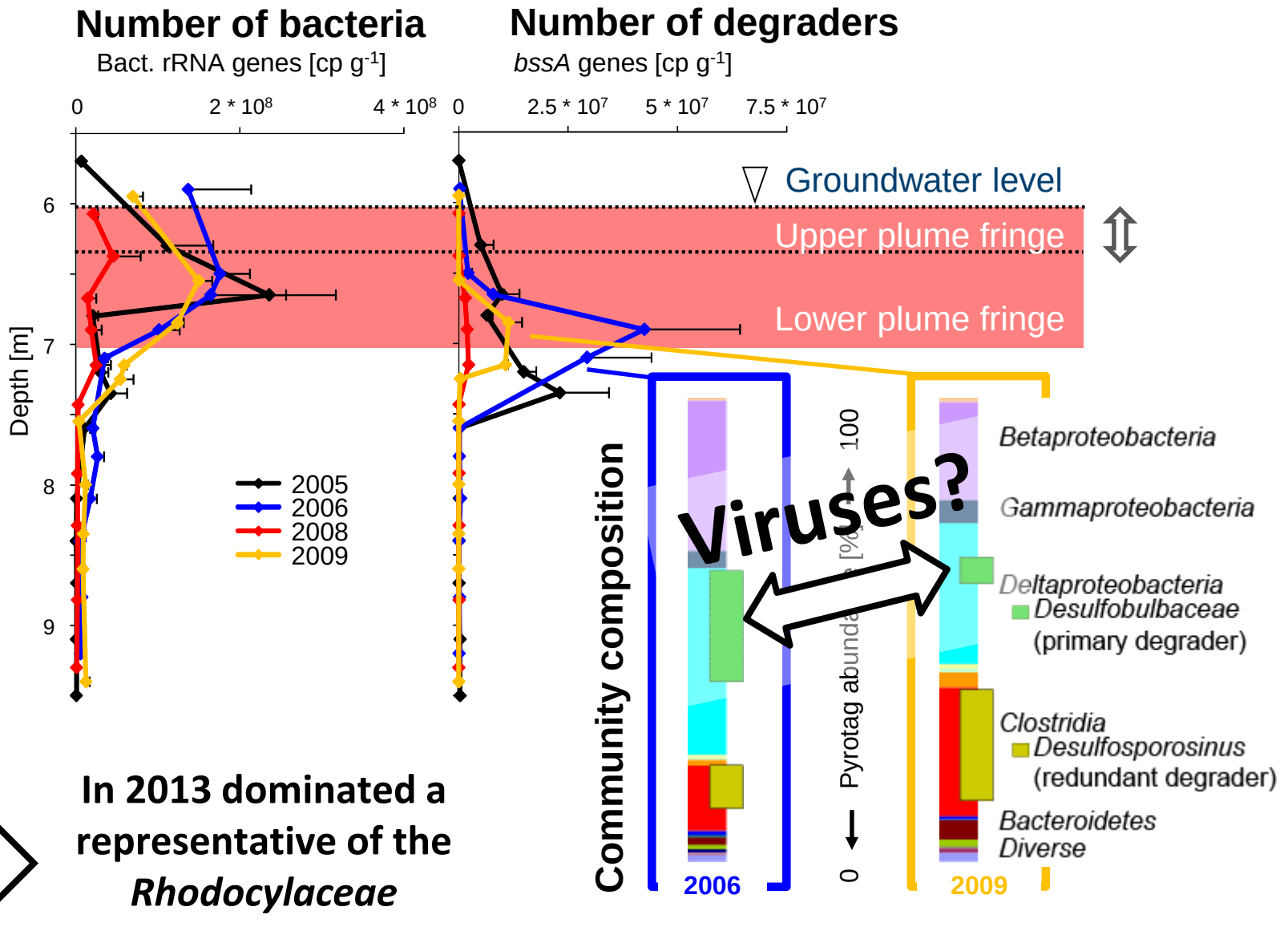


What happened in the Düsseldorf-Flingern aquifer?

2008 to 2009



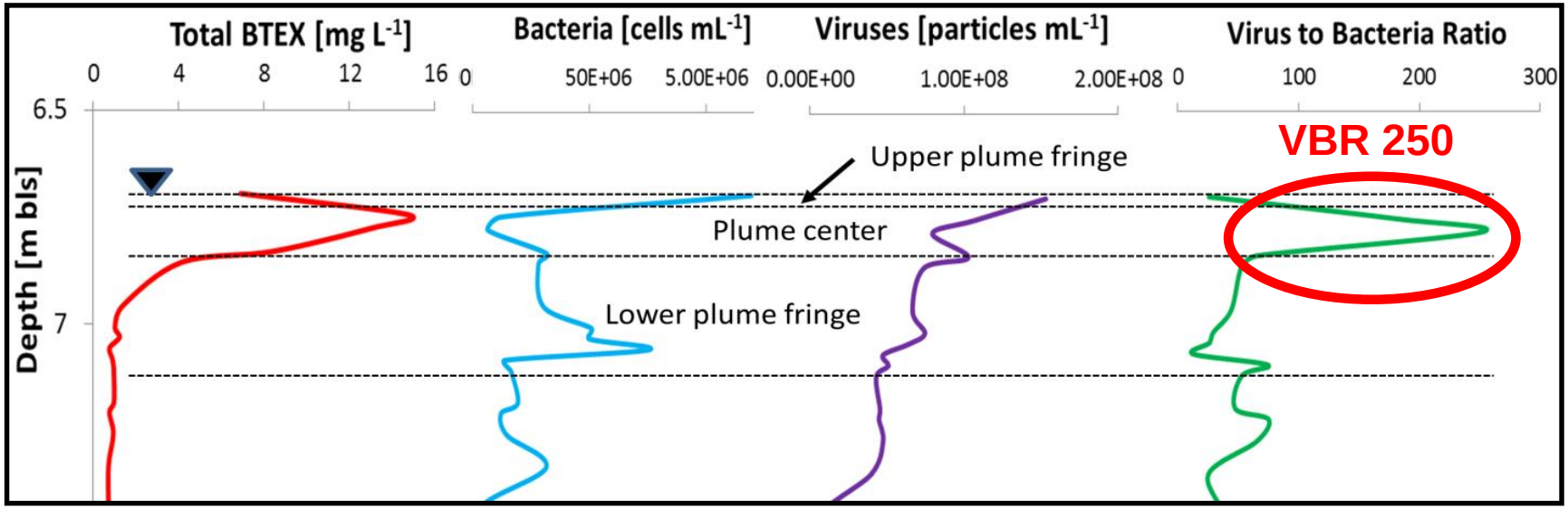
Do abiotic dynamics translate into microbiomes?

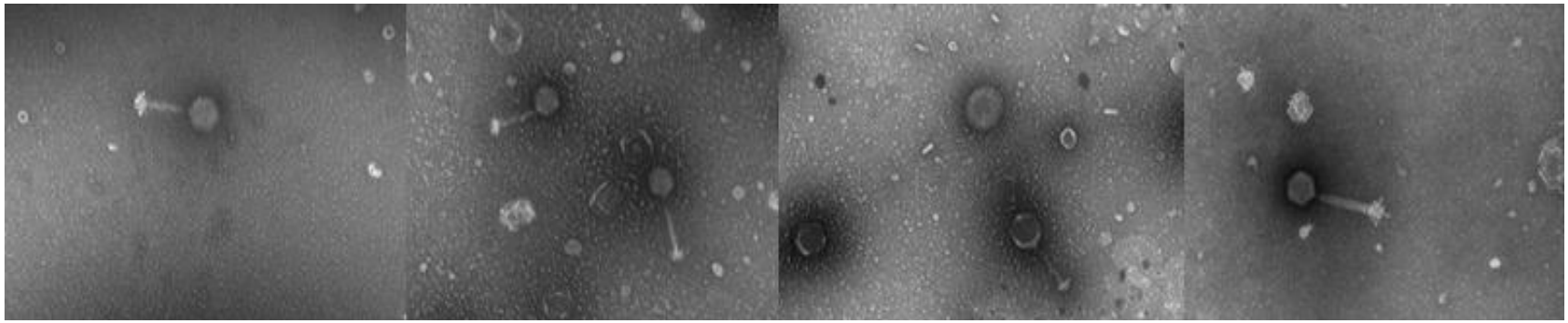


In 2013 dominated a representative of the *Rhodocylaceae* (*Betaproteobacteria*)

Anneser et al. 2010; Pilloni et al. submit.

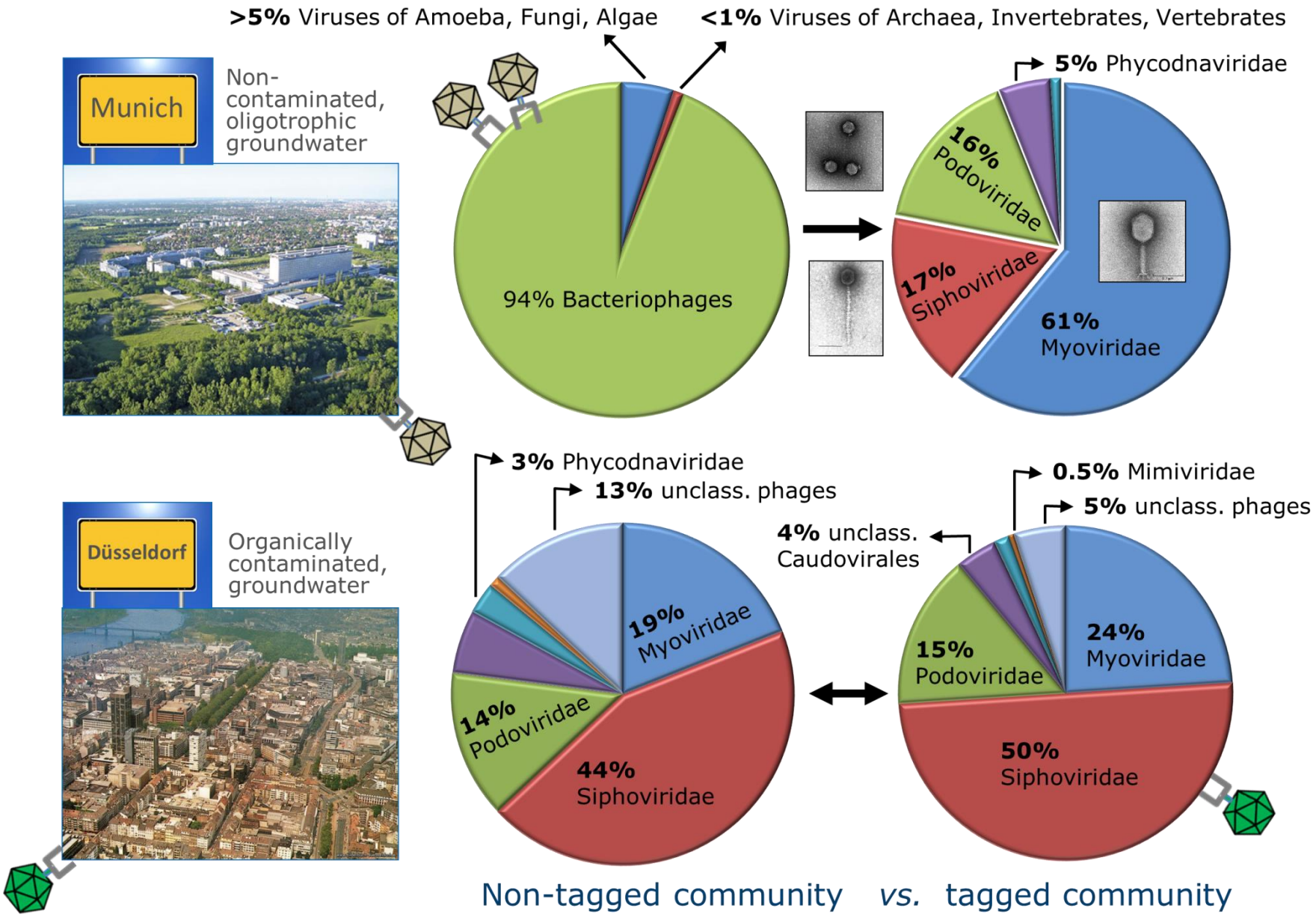
Viruses in a petroleum hydrocarbon contaminated aquifer





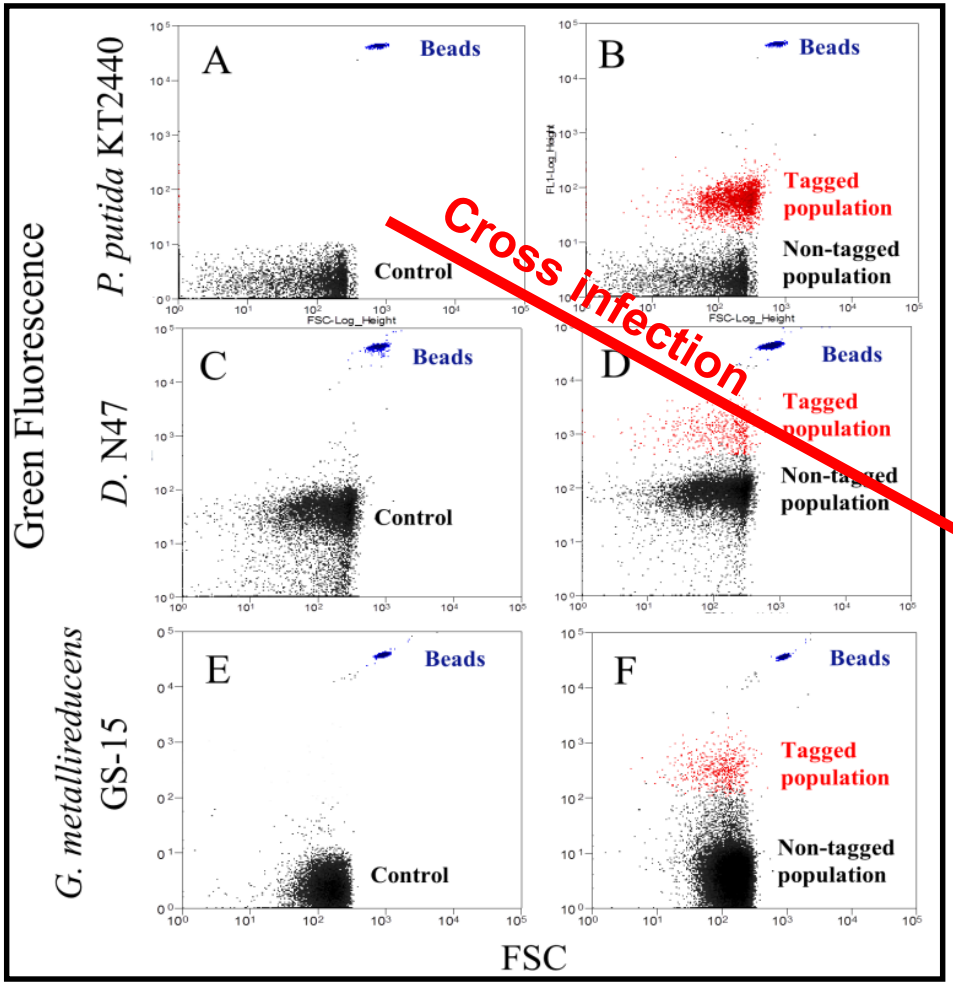
Deng et al, unpubl results

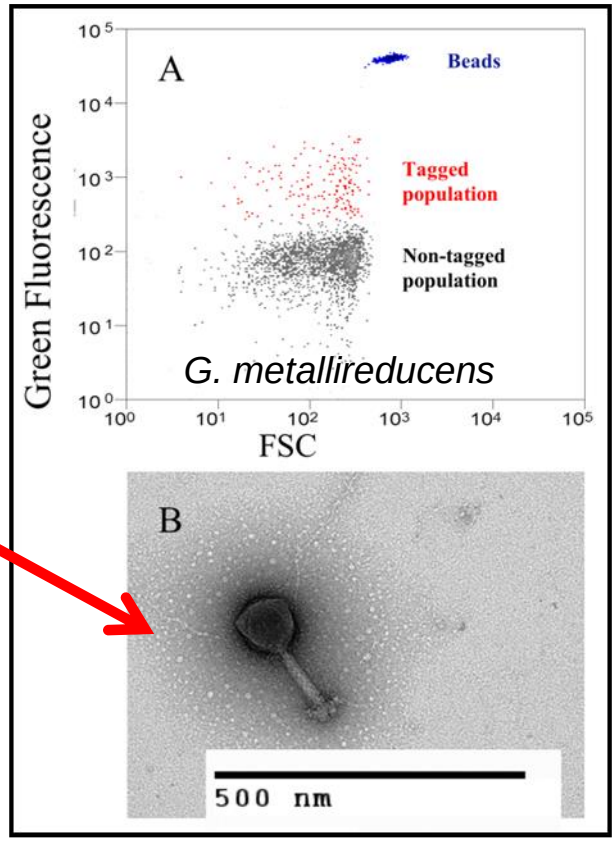
Virus diversity in groundwater ecosystems



Deng & Griebler, unpublished material

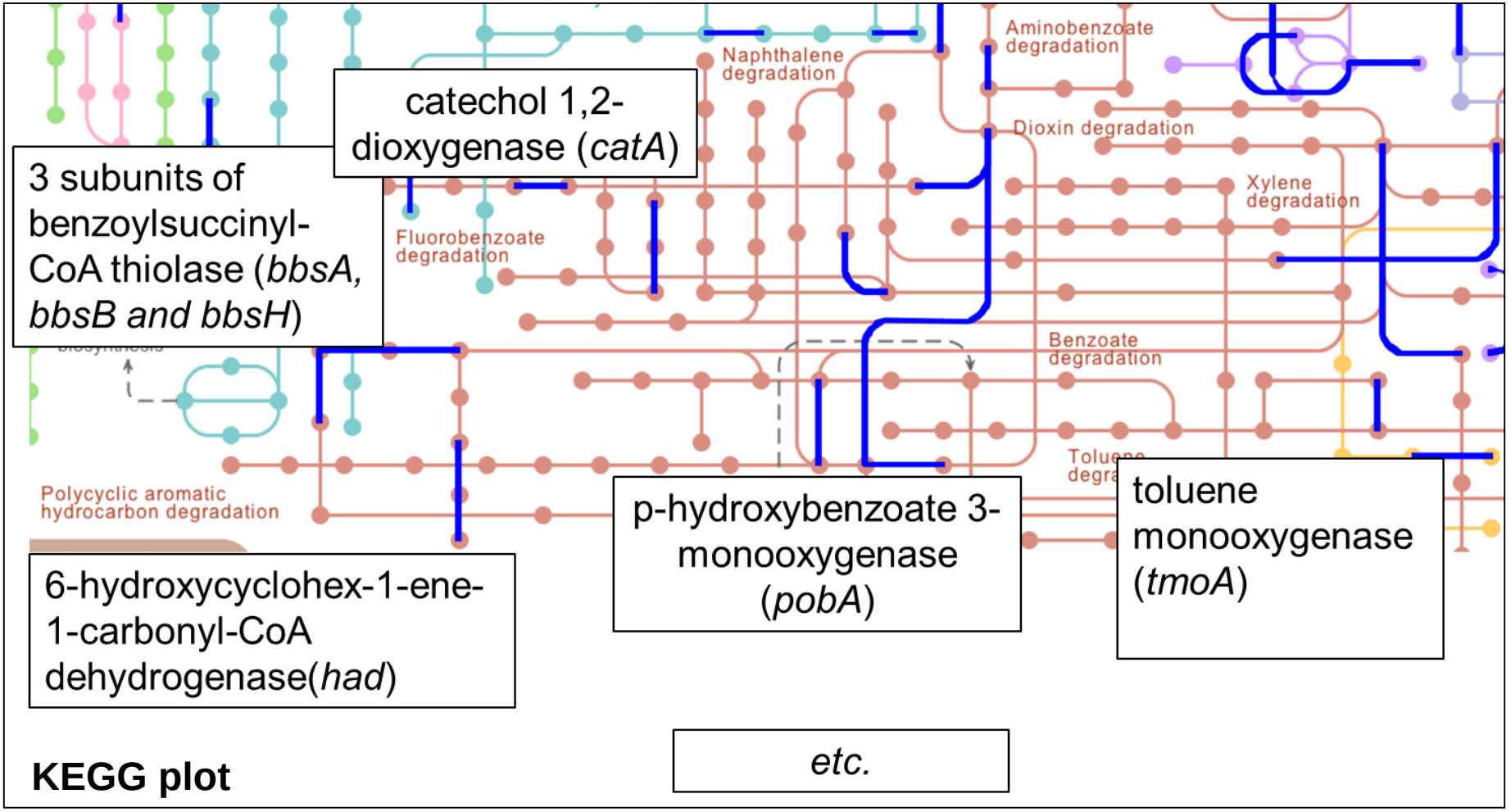
Viruses in a petroleum hydrocarbon contaminated aquifer





Deng & Griebler, unpubl results

Bacterial degradation related genes in the virus fraction of a simplified microbial community



What comes next?

- Detailed study of the role of viruses in microbial aerobic/anaerobic contaminant biodegradation
- Groundwater viral metagenomes from different types of aquifers including different biogeographical regions

Thank you for your attention!

We acknowledge

HelmholtzZentrum münchen
German Research Center for Environmental Health

Tillmann Lüders – IGÖ

TECHNISCHE UNIVERSITÄT MÜNCHEN

Michael Seidel – Department of Analytical Chemistry

universitäts klinikum bonn

Christian Drosten – Inst. of Virology

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Rene Kallies – Department of Microbiology

ExxonMobil

Giovanni Pilloni

Deutsche Forschungsgemeinschaft DFG