Brandenburgische Technische Universität Cottbus - Senftenberg

Leibniz-Institute of Freshwater Ecology and Inland Fisheries

Impact of mining on geochemical signatures of riverine sediments in adjacent ecosystems

A Lusatian Lignite mining area (NE Germany) case study

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Impact of open-cast lignite mining products

Introduction and Objectives

- Lignite mining: worldwide for energy supply

- Inevitable environmental , pollutional effects
  - Pyrite oxidation, iron sulfides are commonly associated with coal

$$FeS_2 + 3.5O_2 + H_2O \rightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$$

$$Fe^{2+} + 0.25O_2 + 2.5H_2O \rightarrow Fe(OH)_3 + 2H^+$$

Nordstrom & Alpers (1999)

- Release of acid, iron (Fe) and sulfate (SO_4^{2-}), heavy metals and aluminium (Al) to groundwater and adjacent aquatic systems
(Hüttl, 1998)

Impact of open-cast lignite mining products

Introduction and Objectives

- Case study: **Lusatian Lignite mining area**
  - Water chemistry of River Spree is heavily influenced by lignite mining
  - Strong decrease of total Fe in water but remaining high SO_4^{2-} concentrations
  - Aim: find signatures, define impact ranges
  - Signatures:
    - Specific element distributions
    - Mineral formations
    - Element turnovers

Further downstream

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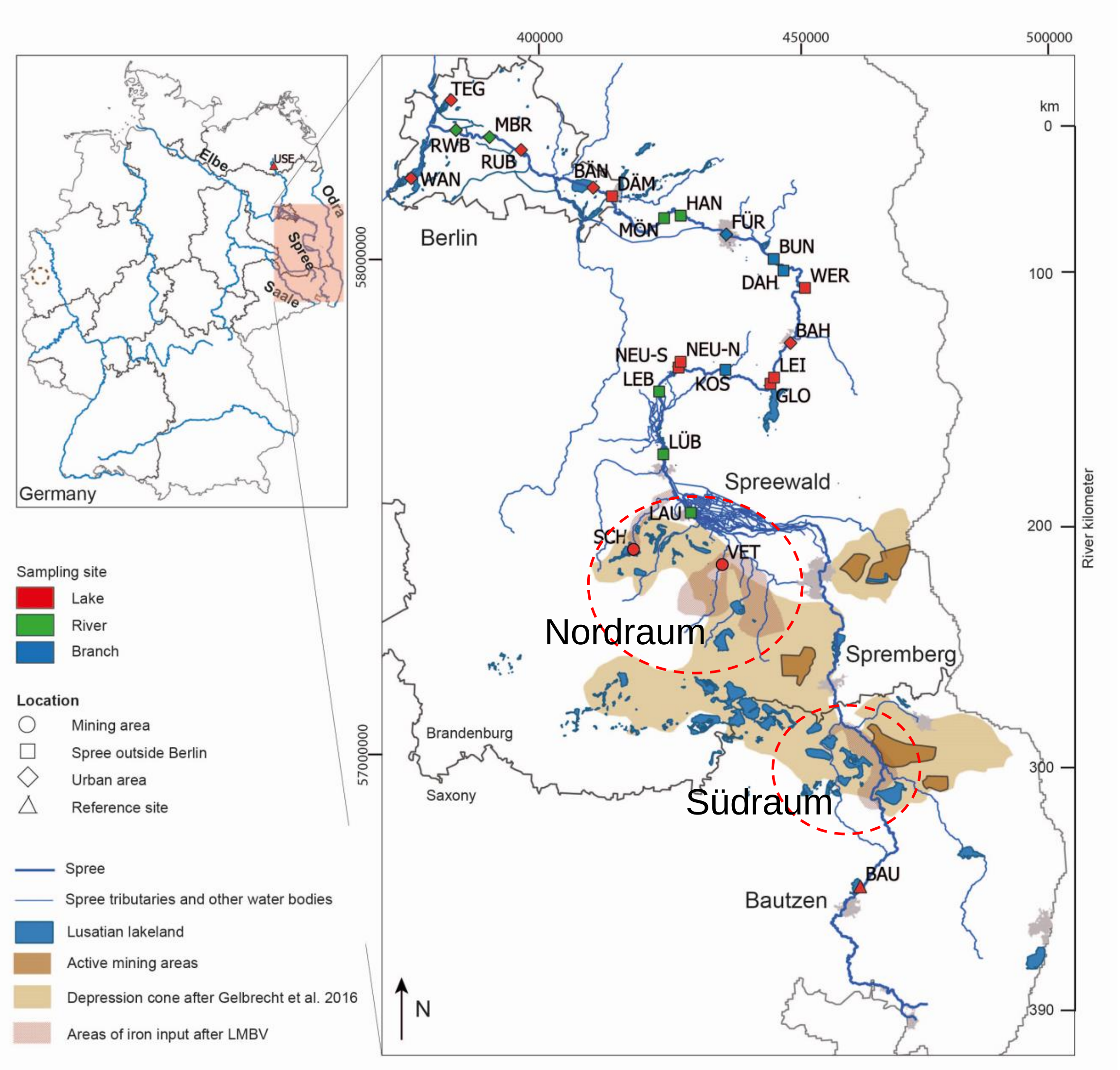
Lusatian Lignite mining area (NE Germany)

- Two areas of input of open-cast mining products ('Nordraum' and 'Südraum')

→ Focus: impact of 'Nordraum'



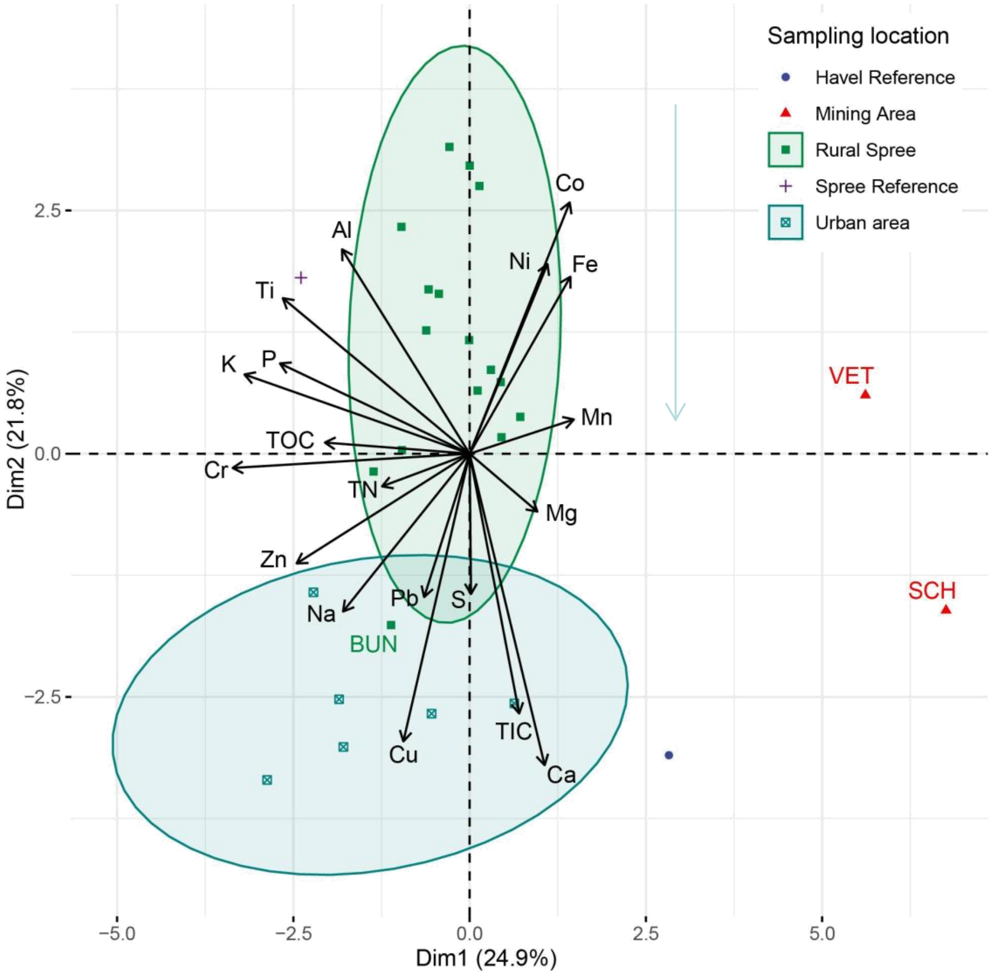
USE, TEG and WAN:
Sediments from Ladwig et al. (2017)

Material and Methods

- Elemental analysis of 19 elements
  - With ICP-OES after digestion with aqua regia ((heavy)metals)
  - With Vario EL analyzer (CN)
  - With photometry after digestion with H_2O_2 and H_2SO_4 (P)
- Four-step sequential iron extraction modified after Tangalos et al. 2010
  - Differentiation of am. iron minerals from more crystalline phases
- Mineralogical analysis with XRD
- Principial Component Analysis (PCA) and other statistical tests using R

Using PCA to find Signatures

- Fe, Ni, Co: rural Spree, VET, SCH
  vs. S
- Al in rural Spree
- Cr, Zn, Pb, Cu: urban areas
  Berlin & Fürstenwalde
- Ca, TIC: urban area, VET, SCH



Sediments in 0-3 cm depth

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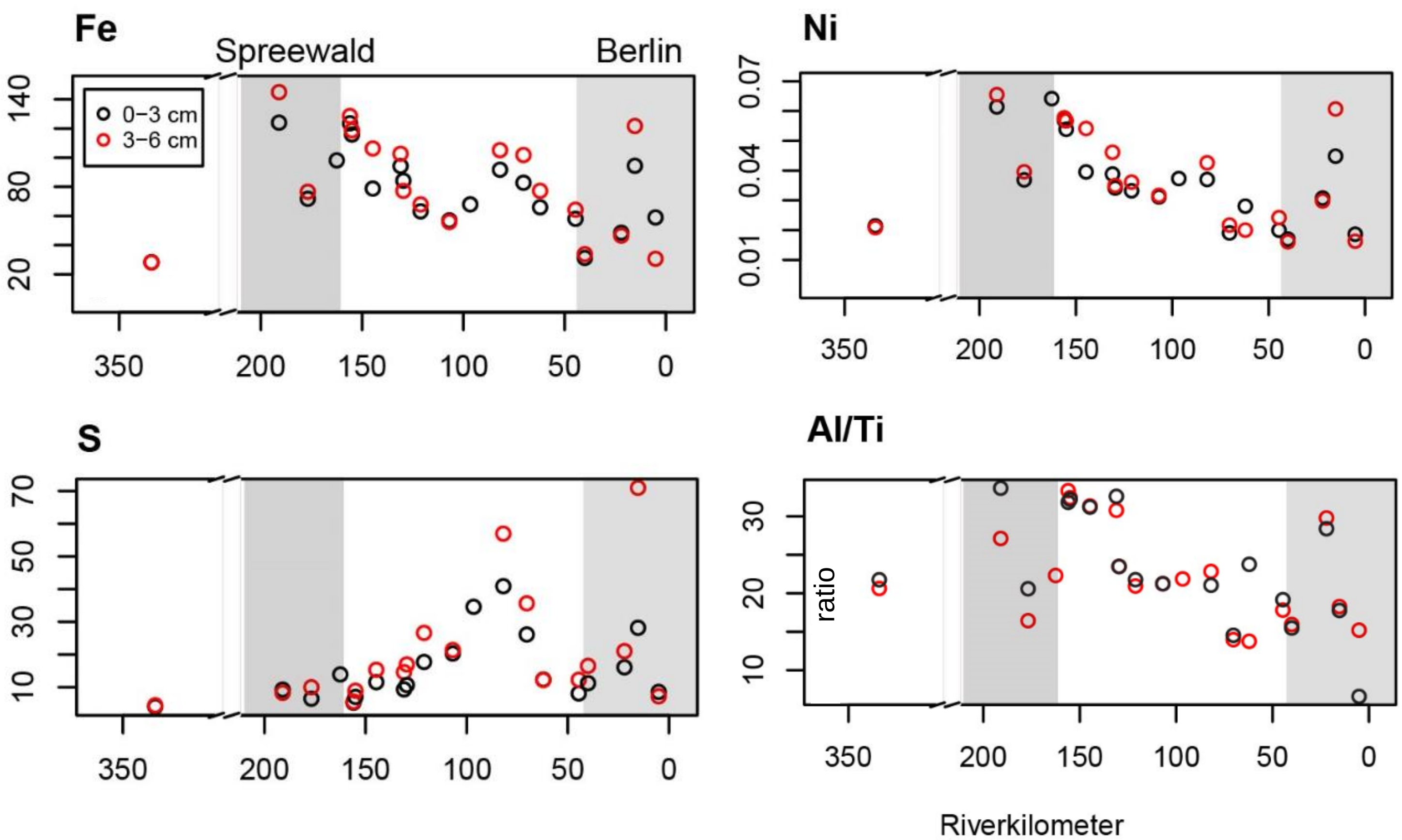
Signatures: Elements/Element ratios along flow path of River Spree



Units mg g^{-1}

- Co-precipitation of Ni and Co onto Fe-Hydroxides

- Excess Al over Ti: Al-Hydroxides

- Pyrite content strongly increasing with increasing S content

Conclusions

- Use of Fe (together with Ni and Co), Al/Ti ratio, S to find impact range of open-cast lignite mining products
- Different impact ranges for Fe and S in sediments
  - Fe (+Ni, Co) and Al Hydroxides - shorter impact range
  - S: longer impact range
  - Sediments in urban area of Berlin are impacted by Cr, Zn, Cu, Pb rather than by open-cast lignite mining products

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References

Gelbrecht et al. (2016): Sulfatbelastung in der Spree – Ursachen, Wirkungen und aktuelle Erkentnisse. IGB Dossier. (in german)

https://www.igb-berlin.de/sites/default/files/media-files/download-files/IGB_Dossier_2016_Sulfat_END.pdf (last access: 20.04.2020)

Hüttl (1998): Ecology of post strip-mining landscapes in Lusatia, Germany. Environmental Science & Policy 1,

DOI: 10.1016/S1462-9011(98)00014-8

Ladwig et al. (2017): Sediment core data reconstruct the management history and usage of a heavily modified urban lake in Berlin, Germany. Environmental Science and Pollution Research 24,

DOI: 10.1007/s11356-017-0191-z

LMBV: Verbessern der Wasserbeschaffenheit im Einzugsgebiet der Spree – LMBV Maßnahmen zur Eisenminderung in der Spree. Poster. (in german)

https://mwfk.brandenburg.de/sixcms/media.php/9/LMBV-Barrierekonzept-Spree.pdf (last access: 20.04.2020)

Nordstrom & Alpers (1999): Negative pH, efflorescent mineralogy, and consequences for environmental restoration at the Iron Mountain Superfund site, California. Proc. Natl. Acad. Sci. USA 96

DOI: 10.1073/pnas.96.7.3455

Tangalos et al. (2010): Microbial production of isotopically light iron(II) in a modern chemically precipitated sediment and implications for isotopic variations in ancient rocks. Geobiology 8,

DOI: 10.1111/j.1472-4669.2010.00237.x