



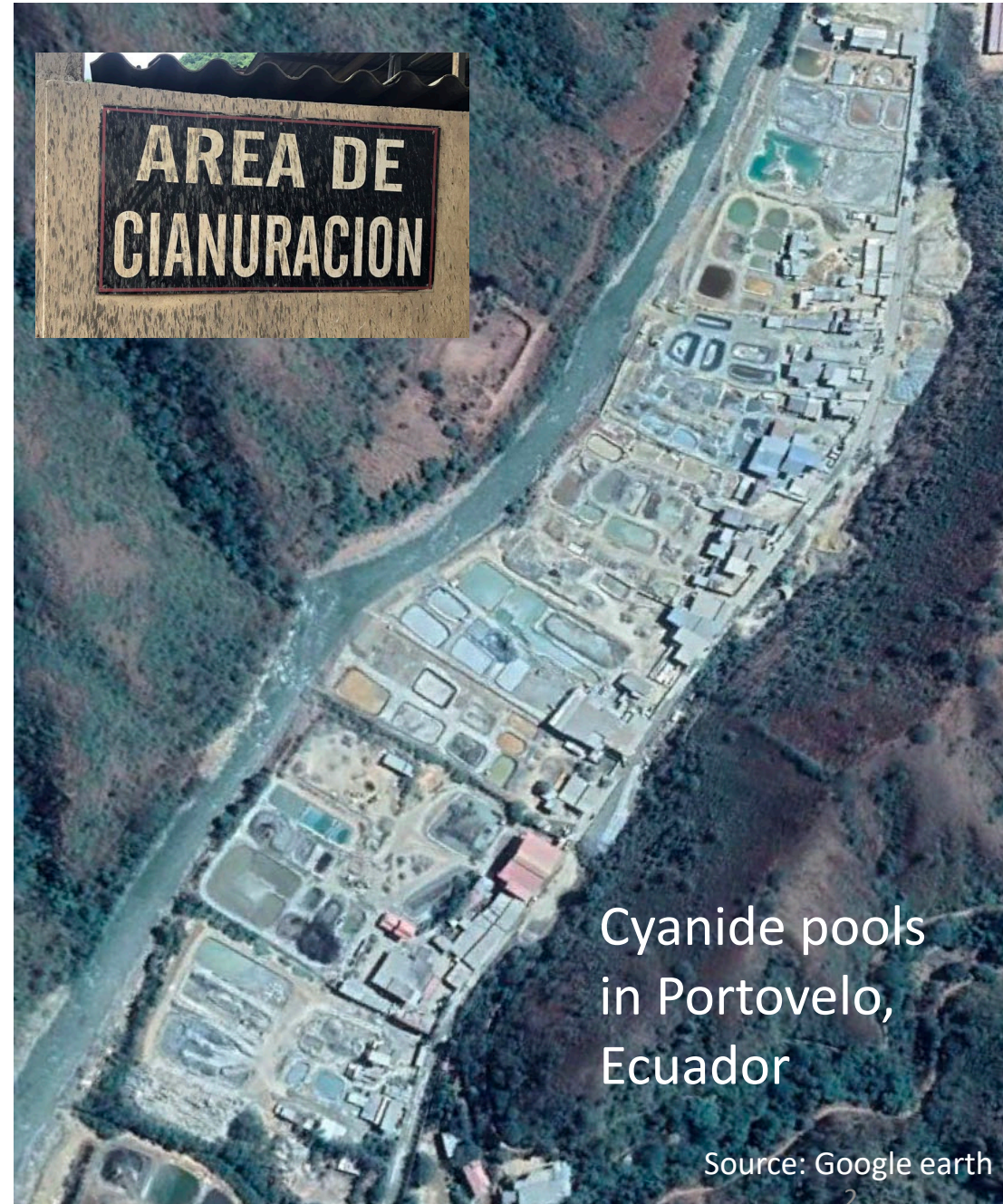
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## **Fate, transport, and bioavailability of mercury downstream of cyanidation plants in a major ASGM-impacted river**

**Shannon Plunkett**, Dr. Emily Bernhardt, Dr.  
Melany Ruiz, Dr. Carlos Mena, Dr. William Pan, Dr.  
Seth O'Neal, David Toscano, Dr. Heileen Hsu-Kim



Mercury and cyanide increasingly coexist in ASGM



Cyanide pools in Portovelo, Ecuador

Source: Google earth

# Mercury and cyanide increasingly coexist in ASGM

Cyanide increases gold recovery from ~30% to ~80% compared to mercury alone (UNEP, 2013)



Cyanide pools in along Puyango-Tumbes river, Ecuador

Source: Google earth

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Scientific documentation from 16 countries and the practice is expanding (Verbrugge et al., 2021)



Cyanide pools in along Puyango-Tumbes river, Ecuador

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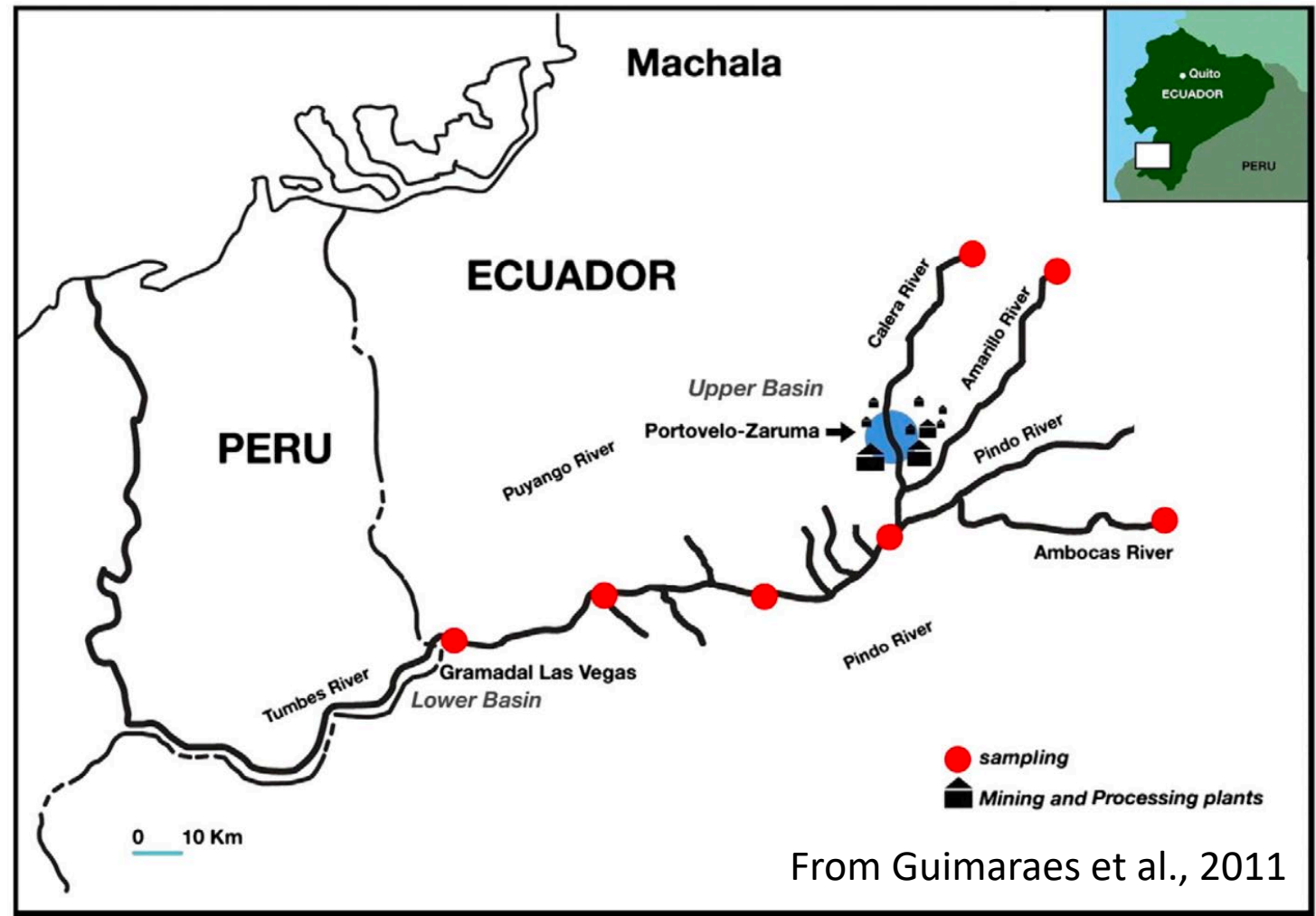
Bioavailability and toxicity to methylating microbiota never tested explicitly



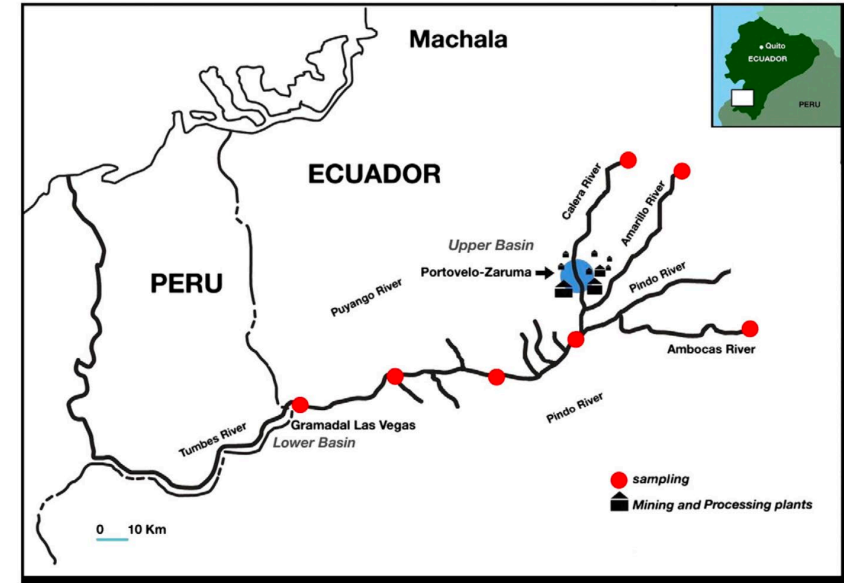
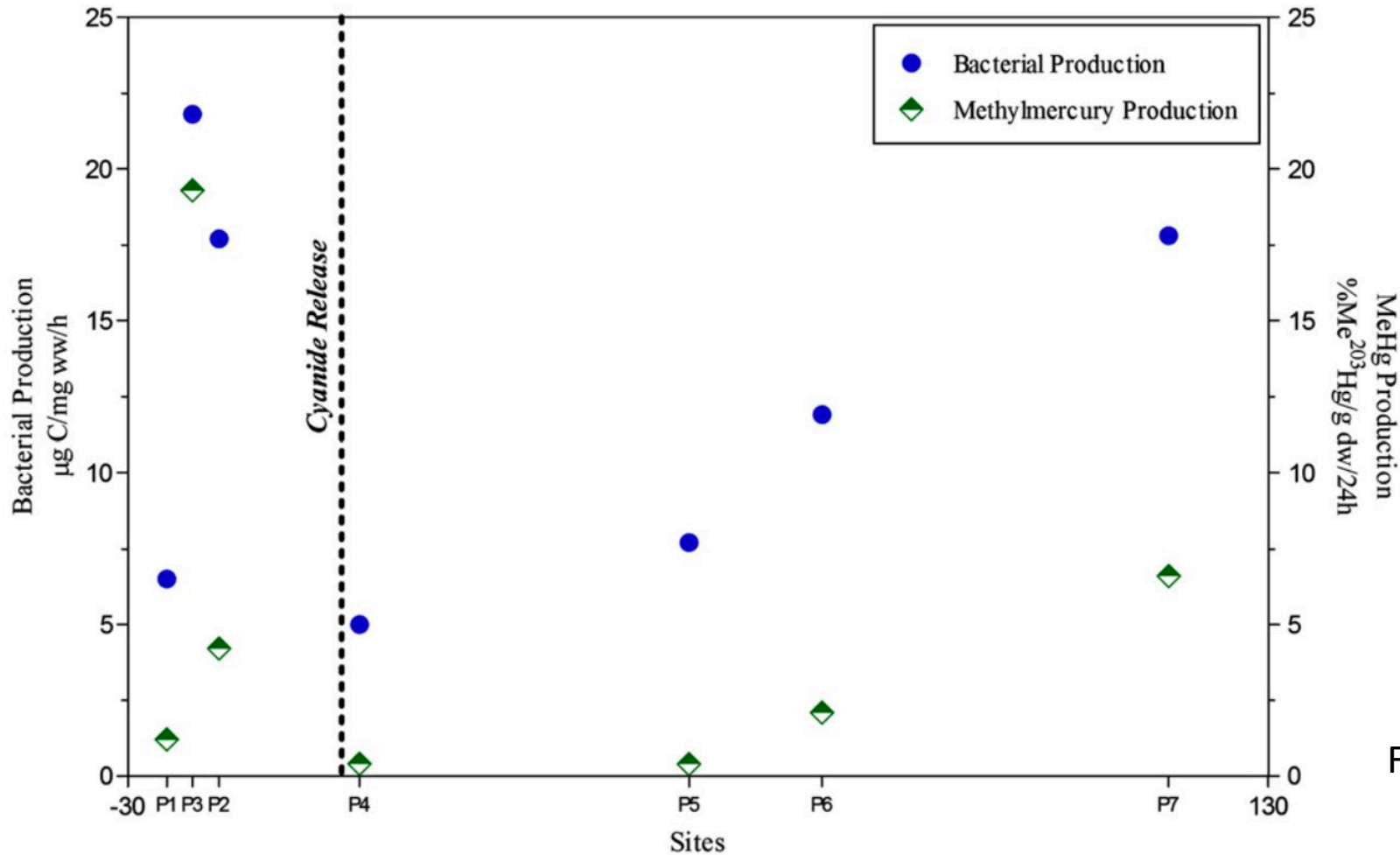
Cyanide pools in along Puyango-Tumbes river, Ecuador

Source: Google earth

# Puyango-Tumbes river



Sediment methylation *potential* increases with distance from cyanide release



From Guimaraes et al., 2011

# Research objectives

- Conduct first long-range study on how methylmercury concentrations in water and sediment change downstream of mercury and cyanide ore processing.
- *Infer* biogeochemical controls on MeHg concentrations in sediment and water in this system for further investigation in a controlled experiment.

# Methods

Collected sediment and water (unfiltered and  $< 0.45$  micron) along 195 km reach.

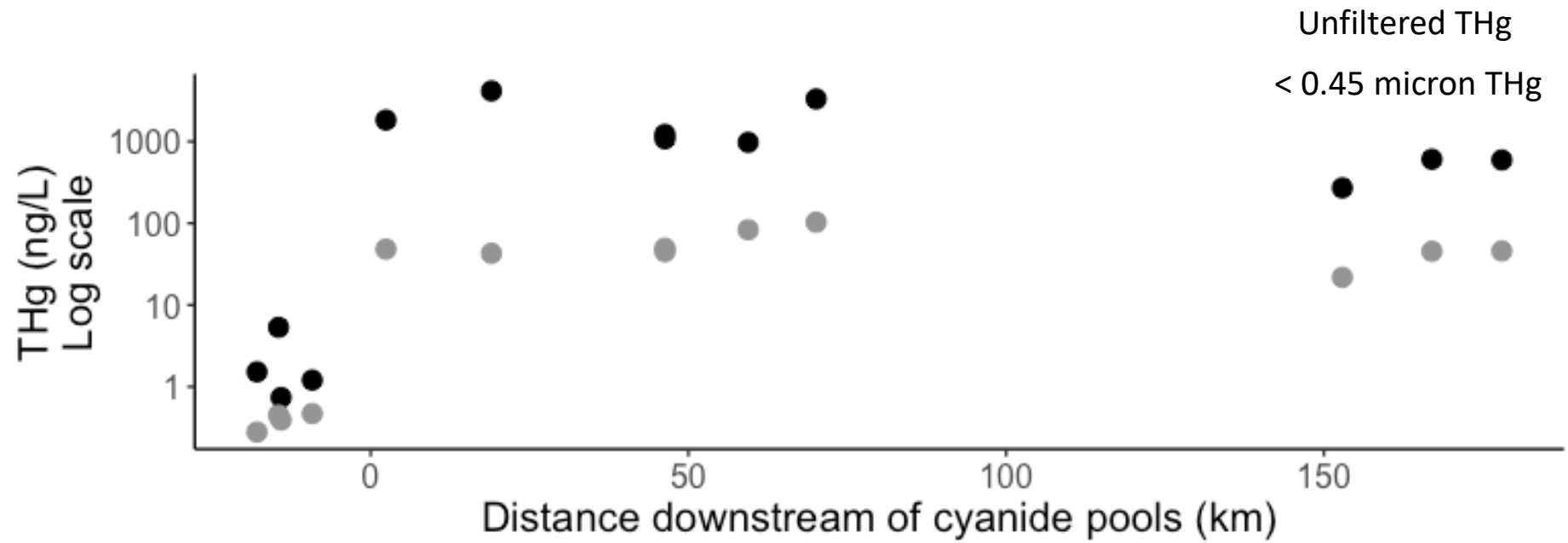
Analytes:

- THg
- MeHg
- Cyanide
- TOC/DOC
- major anions
- elements by ICP-MS

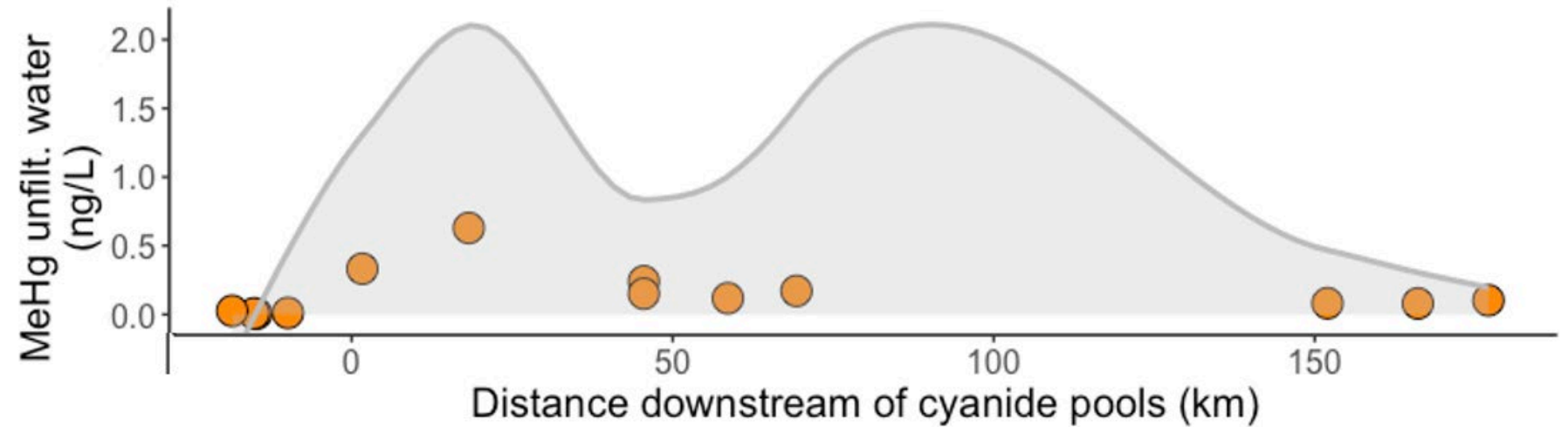
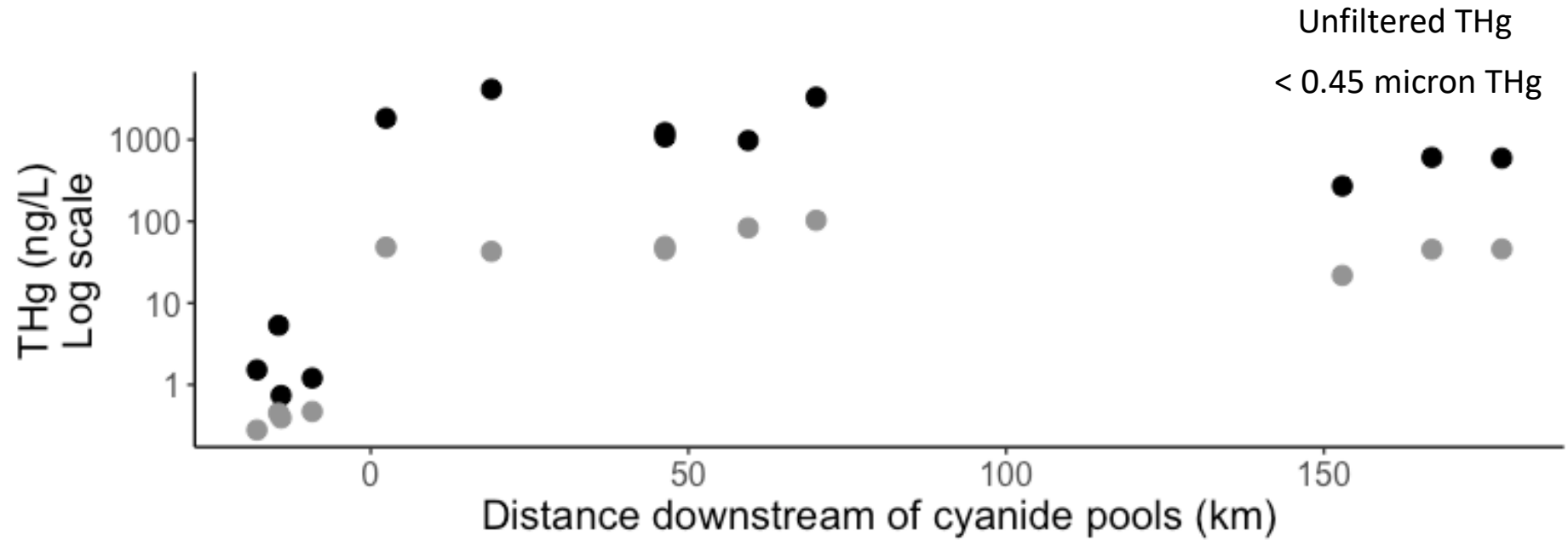
-In situ conditions  
(DO, salinity, pH etc)



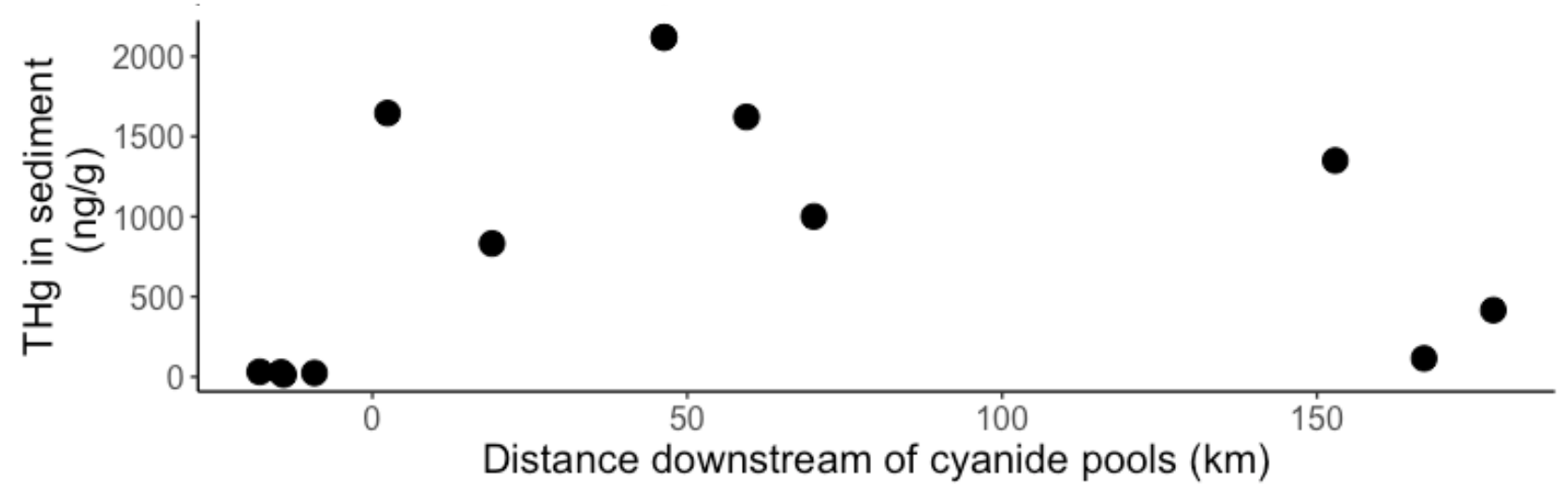
# Results: Water



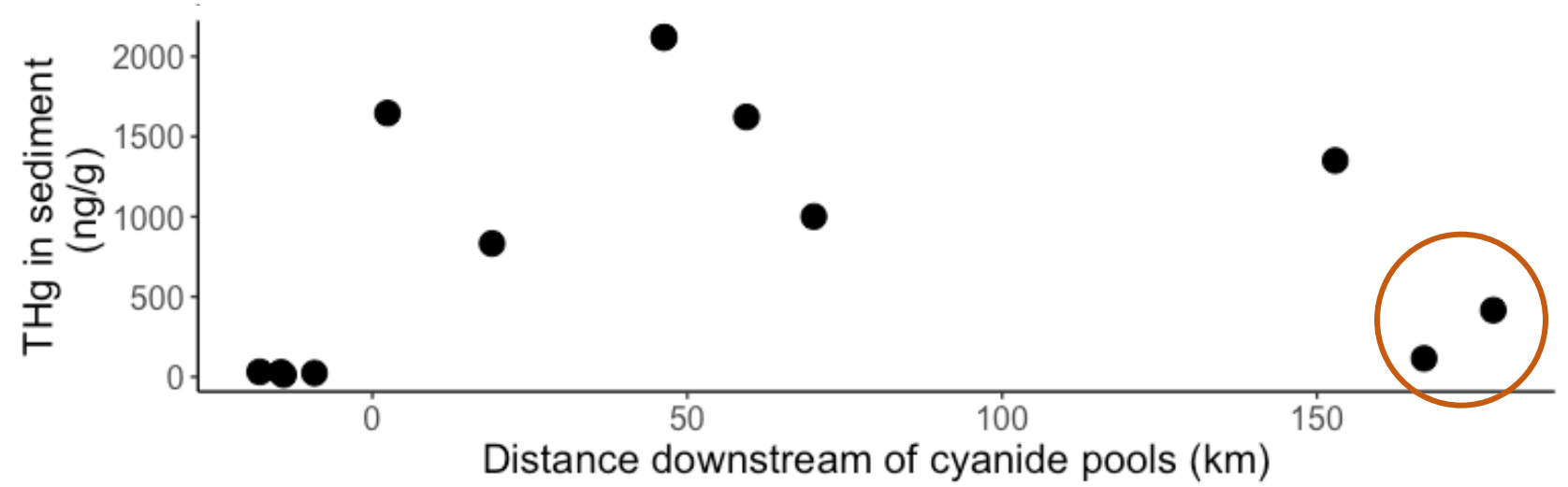
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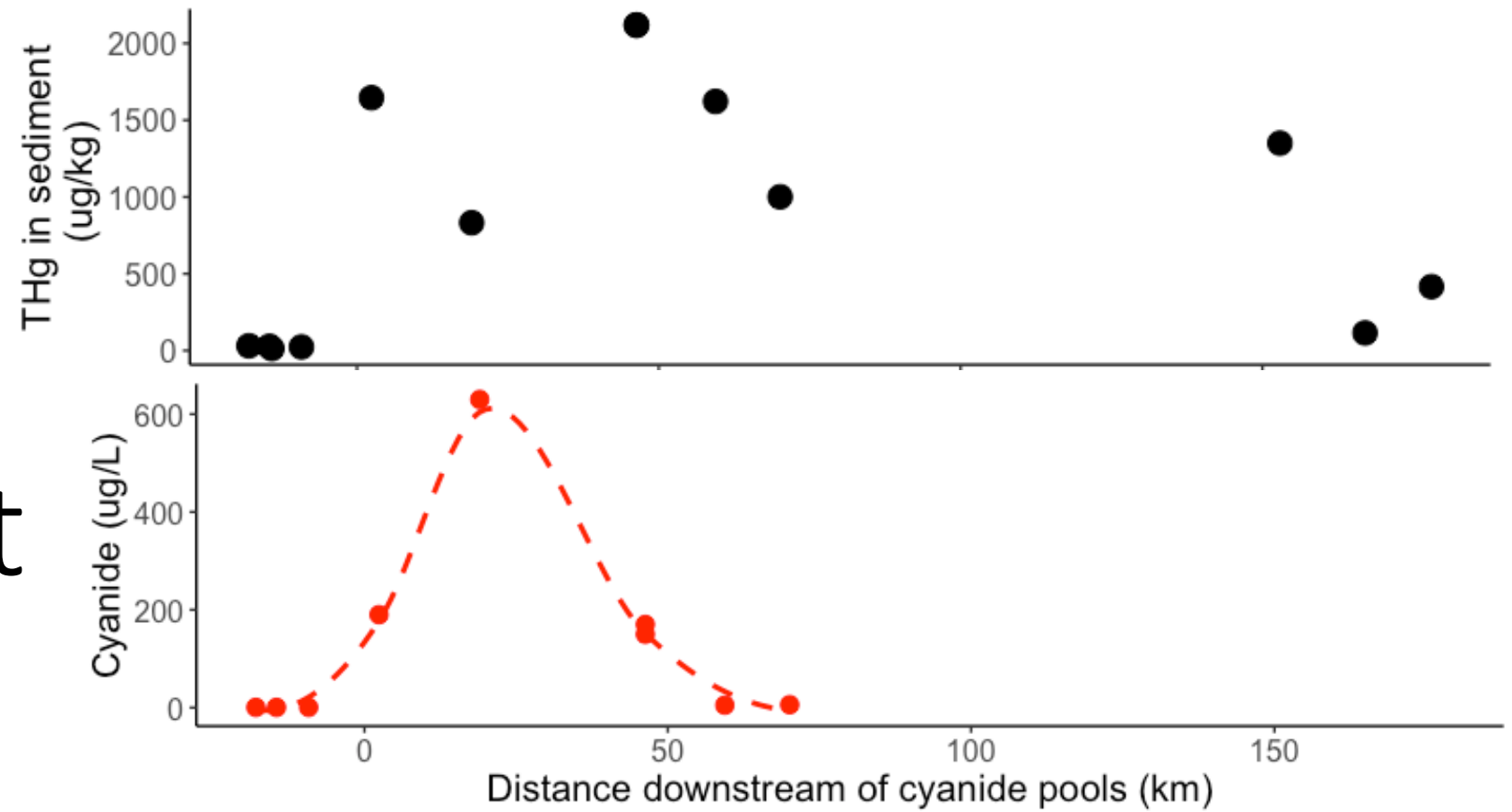
# Results: Sediment



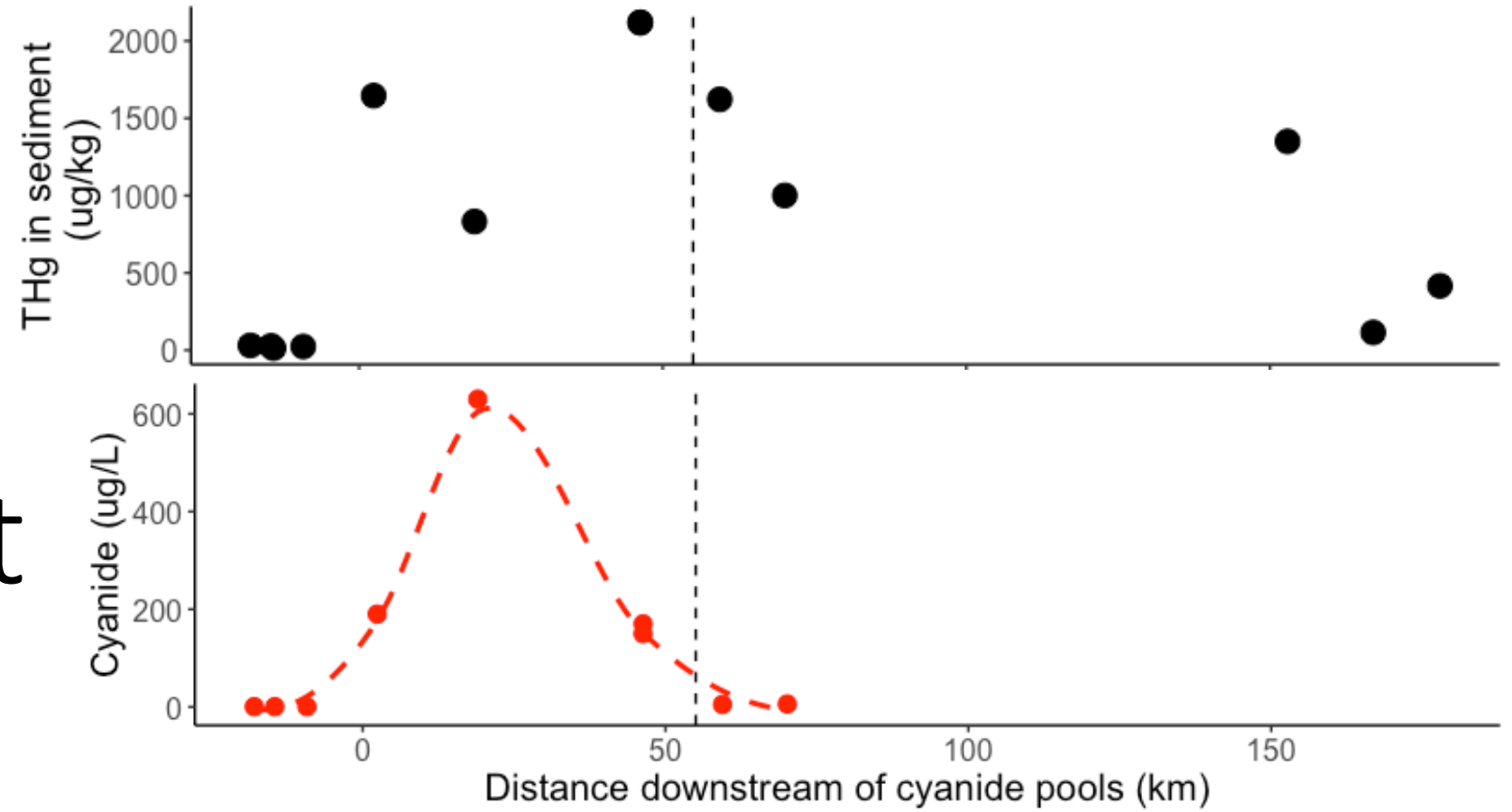
# Results: Sediment



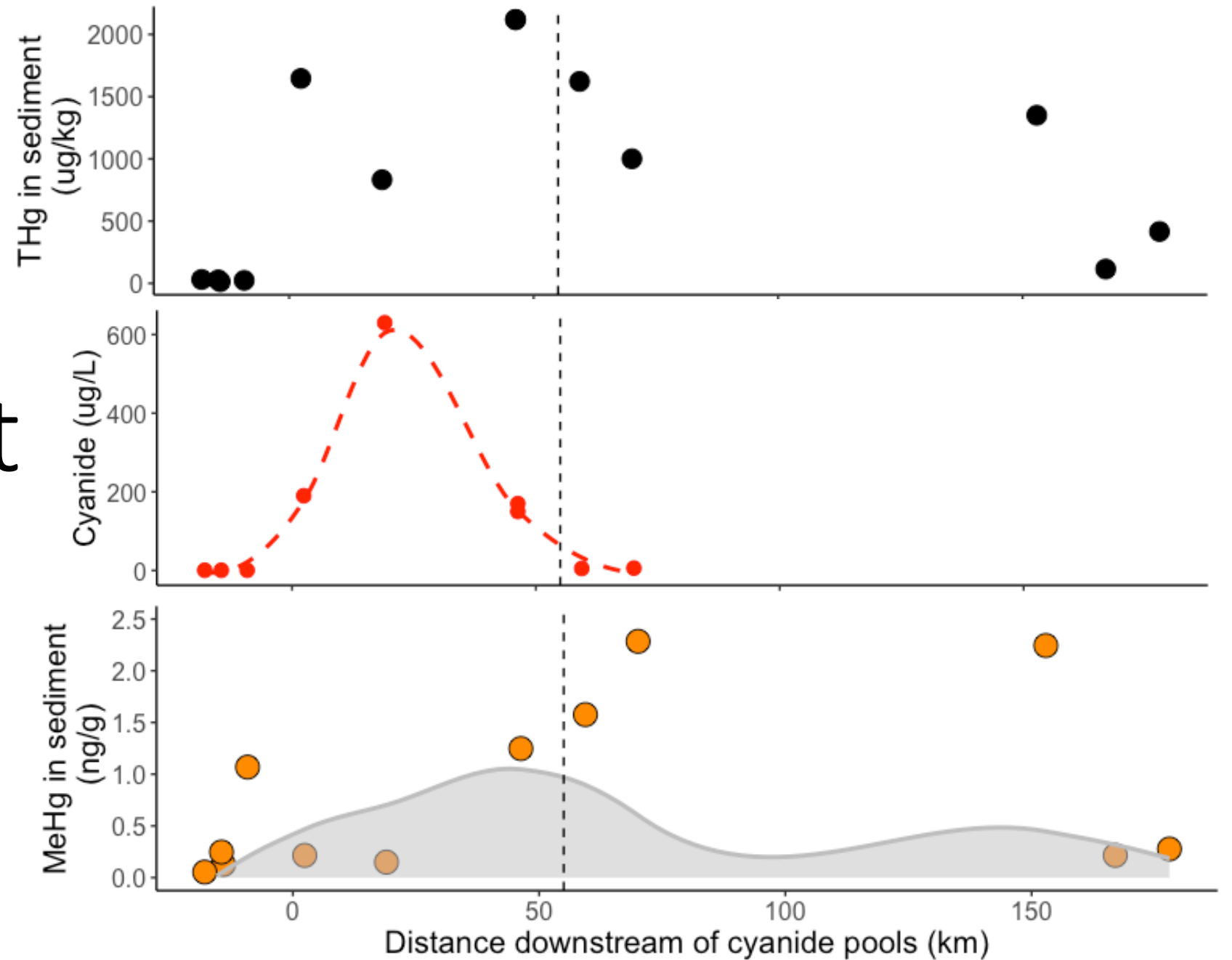
# Results: Sediment



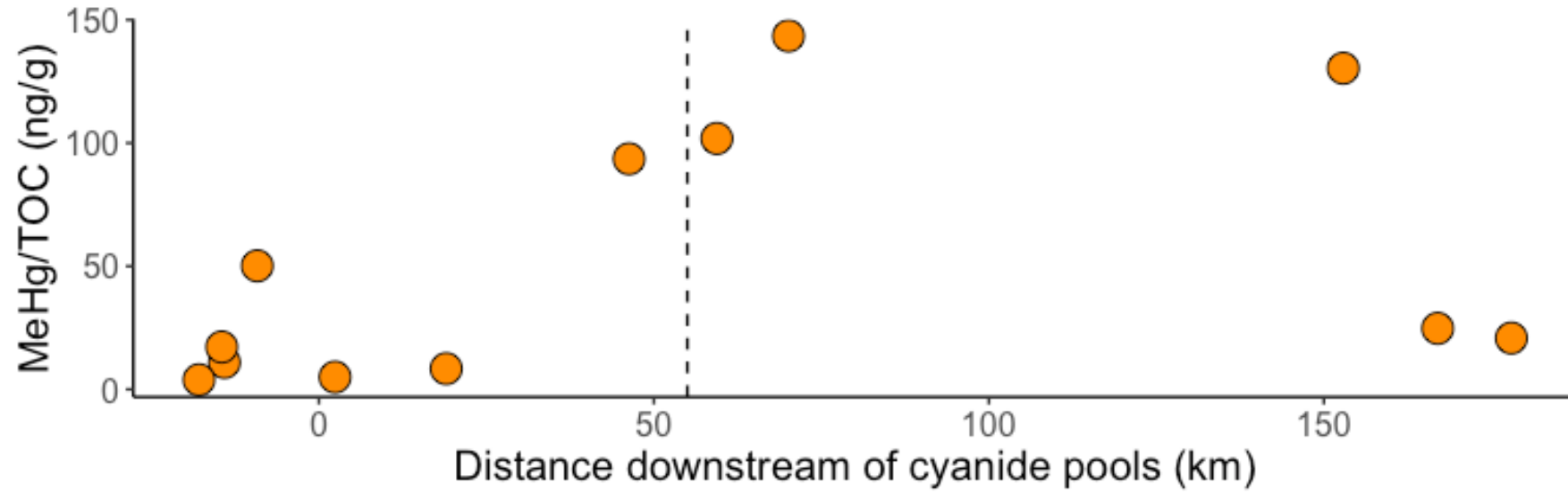
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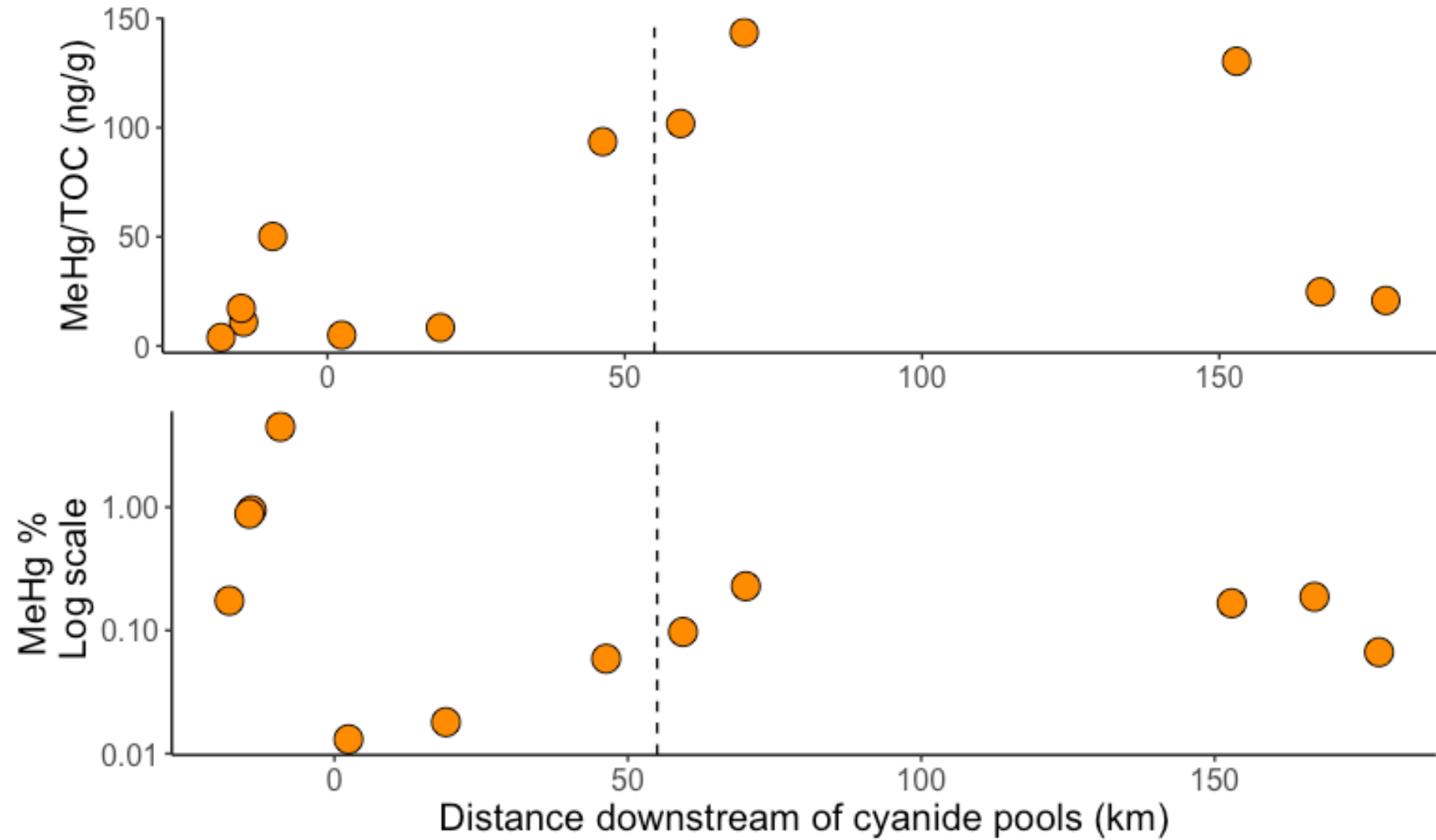
# Results: Sediment



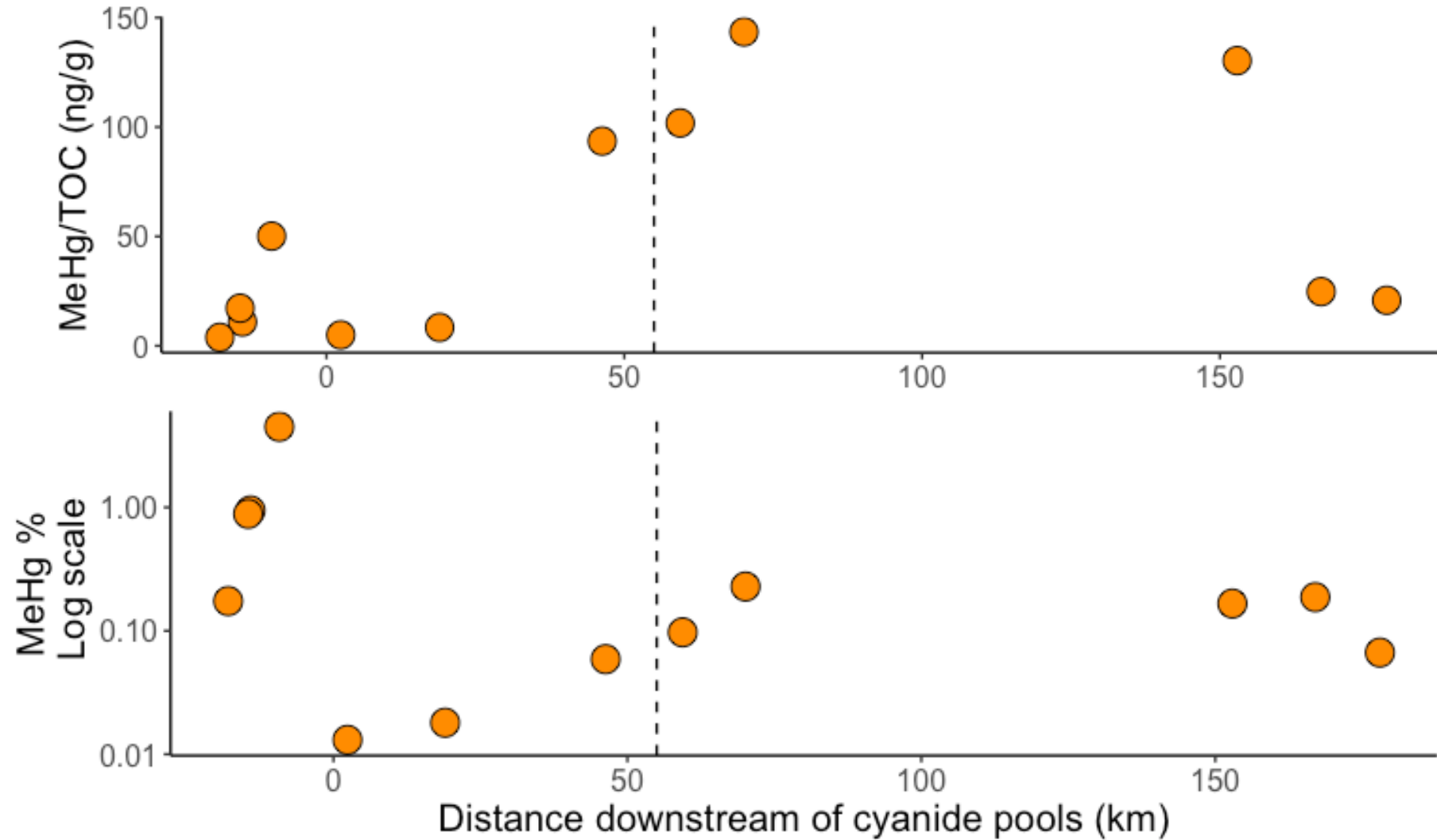
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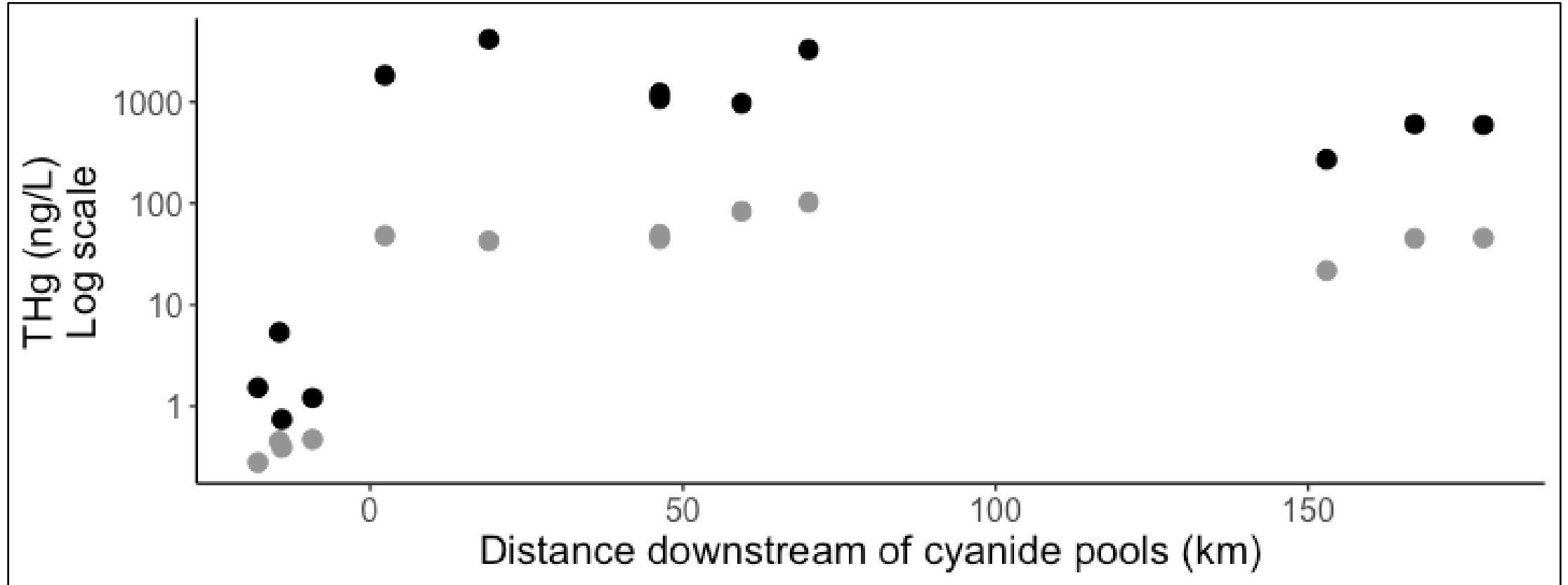


# Results: Sediment



Support for cyanide suppression of mercury methylation in sediment

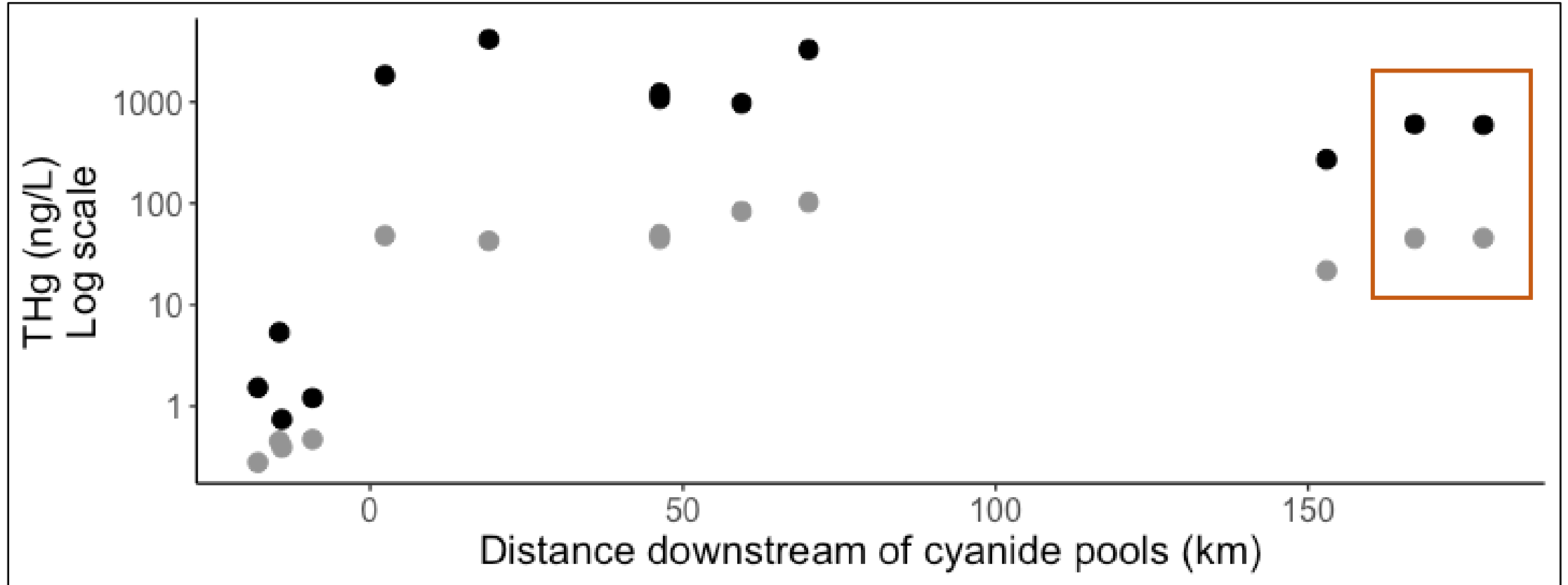
THg in water remains elevated more than 175 km downstream of ore-processing



Unfiltered THg

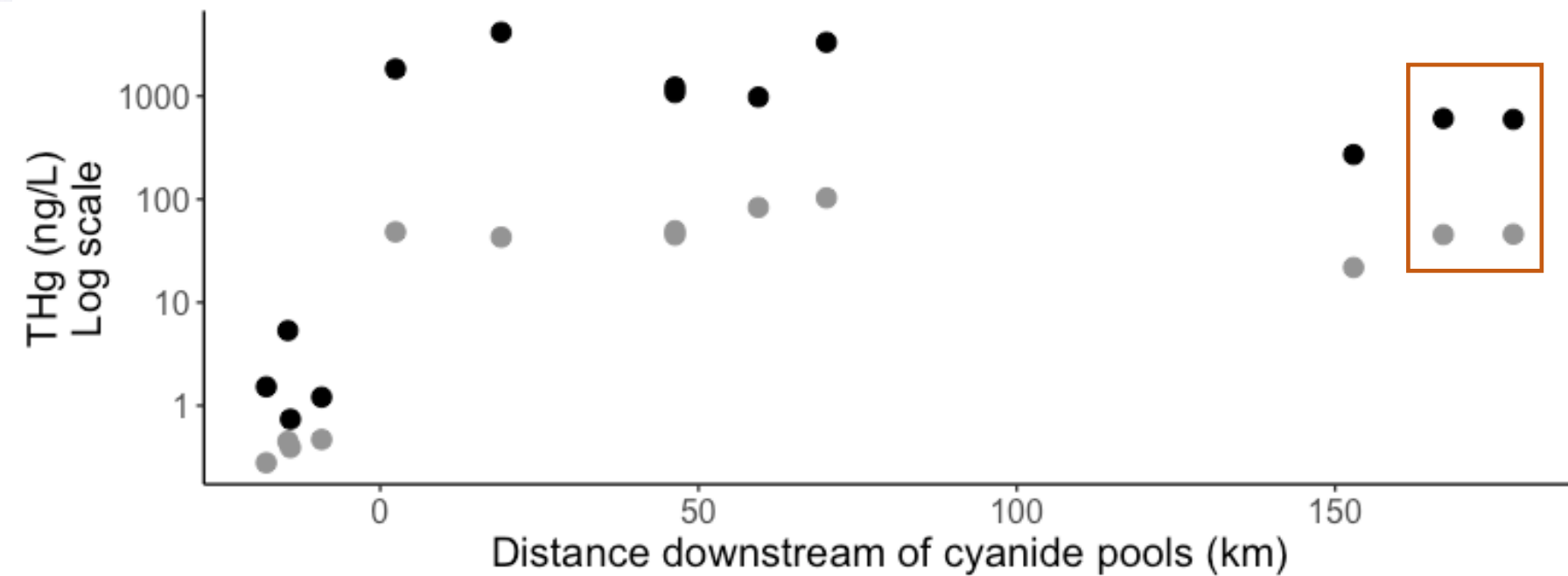
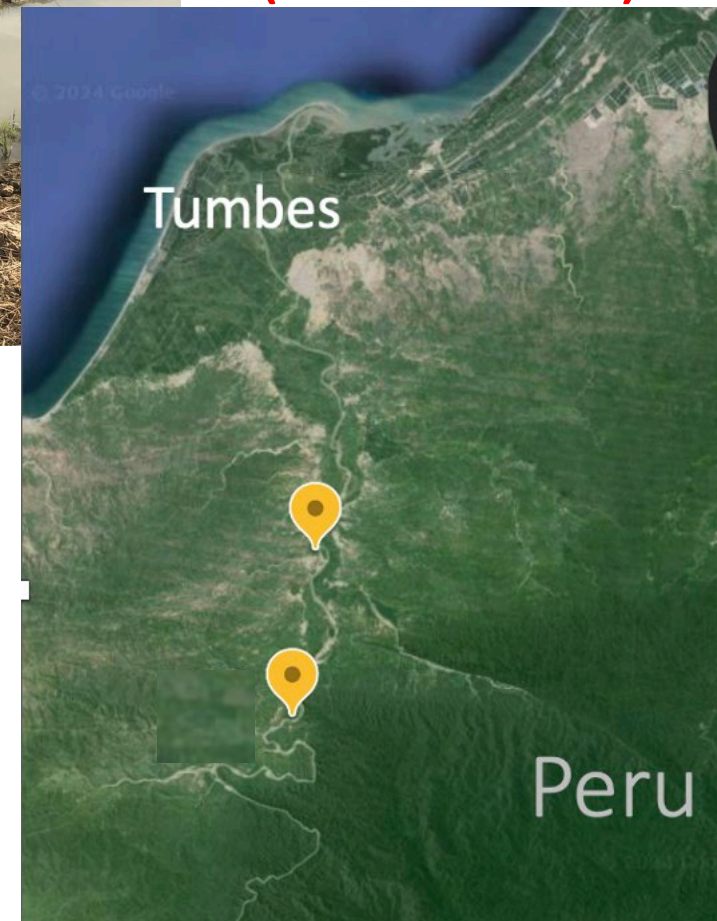
< 0.45 micron THg

THg in water remains elevated more than 175 km downstream of ore-processing





610 ng  
Hg/L  
(max 1100)



1. Rivers downstream of Hg/cyanide coprocessing may have a different rules governing THg and MeHg concentrations

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2. Concentrations of MeHg in sediment are consistent with the cyanide suppression hypothesis
3. Despite no MeHg in water column, concentration of THg maintained in water column downstream of Hg/cyanide processing poses a major threat to areas downstream

Cyanide appears to present a unique biogeochemical constraint that suppresses methylmercury concentrations and stretches the extent of river highly contaminated with total mercury.

# Thank you.

Thanks to the MedX Initiative at Duke University for funding this research.

Many thanks coauthors Dr. Emily Bernhardt, Dr. Melany Ruiz, Dr. Carlos Mena, Dr. William Pan, Dr. Seth O'Neal, David Toscano, Dr. Heileen Hsu-Kim and to field technicians Kaila Balch and Payton Wood.

# Questions?

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