Thermal desorption mercury records across British Rhaetian–Hettangian sections: Implications for the sedimentary Hg paleovolcanism proxy

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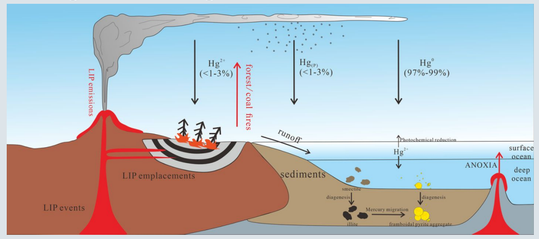
Introduction

Ancient volcanism, environmental change

- Central Atlantic Magmatic Province (CAMP): volcanism associated with the end-Triassic mass extinction
- Volcanic emissions: potential drivers of warming and ecosystem disruption
- Sedimentary records: evidence for the timing and magnitude of past emissions

Why mercury?



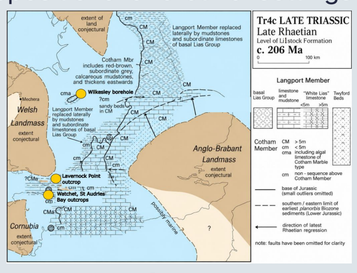
(Xu et al., 2023)

Key question: post- and syn-depositional influences on sedimentary Hg enrichment

Multi-site basin approach

Wilkesley: Cheshire Basin borehole
Watchet, Lavernock Point, St Audries Bay: Bristol Channel Basin outcrops

- 571 samples spanning the late Triassic–early Jurassic
- Comparable stratigraphy, different depositional and burial settings



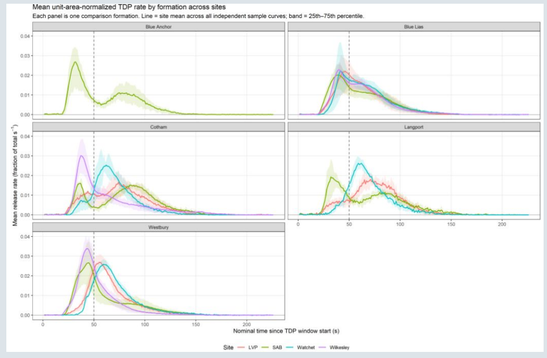
Study approach

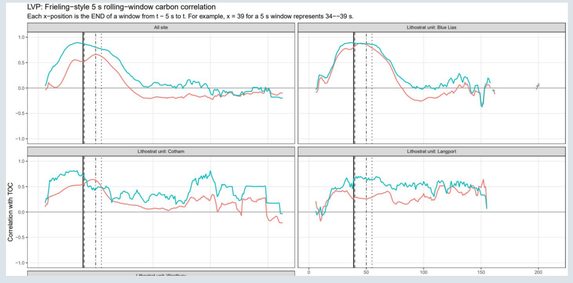
- Identify recurring mercury enrichment
- Test differences in mercury retention
- Compare records after accounting for sedimentary controls

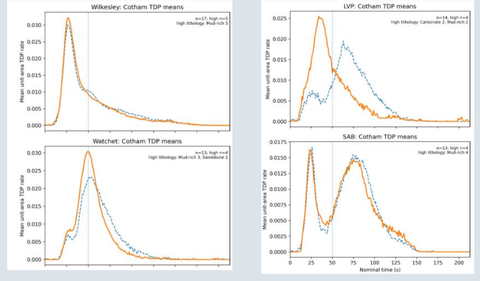
Methodology

Materials

- **Wilkesley:** archived British Geological Survey borehole material; approximately one-foot sampling intervals, 221 samples
- **Watchet:** 30 coastal outcrop samples from Helwell Bay, Somerset; Davies (2025)
- **Lavernock Point:** 74 coastal outcrop samples from South Wales; Pantazopoulou (2023)
- **St Audries Bay:** 246 samples from the Somerset coastal section; collected by Stephen Hesselbo and Stuart Robinson (Hesselbo et al., 2004)







1. Measure mercury abundance

Total mercury concentration
Total organic carbon (TOC): a major potential mercury host
Hg/TOC: conventional measure of enrichment relative to organic carbon

2. Measure mercury release during heating

Thermal desorption profiles (TDPs): mercury release through time
Profile shapes compared independently of total mercury abundance
Shared operational division:
HgLT: release through 50 s
HgHT: release after 50 s
Different release patterns: evidence of different binding environments
Specific host minerals remain unidentified

3. Test sedimentary controls

Mercury–TOC correlations through the heating run
Comparisons within formations and among sites
Carbonate and lithology as additional sedimentary context

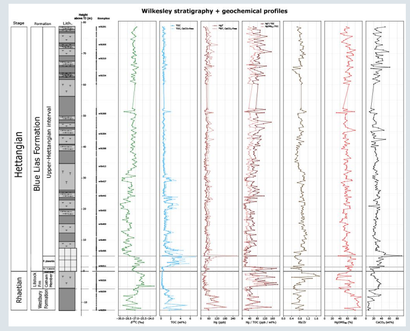
4. Estimate mercury above background

R package Robustbase
Nonlinear models of the mercury–TOC relationship
Residual mercury = measured − predicted mercury
Further tests for relationships with TDP shape

Discussion

A recurring enrichment, different local records

- Cotham Member Hg/TOC enrichment at all four sites
- Different magnitudes and detailed stratigraphic patterns
- Consistent with a regional mercury-cycle disturbance
- Volcanic input and sedimentary change remain difficult to separate



Insights from TDPs

- Blue Lias: greatest broad similarity among sites
- Cotham and Langport: more variable release patterns
- Equivalent stratigraphy does not guarantee equivalent mercury retention

Conclusions

- Cotham enrichment at all four sites, without a common TDP shape or lithology; supports external forcing over a simple facies-driven explanation
- Long, internally consistent intervals such as Mochras better suited than rapidly changing British T–J successions
- Greatest cross-site similarity in the Blue Lias; greater Cotham–Langport variability suggests depositional control beyond broad lithology

Understanding how sediments retain mercury is essential to reconstructing Earth's carbon cycle history.