

Mercury Emissions from Icelandic Volcanism



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Main Conclusions



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Exceptionally low mercury concentrations and fluxes from the 2021 and 2022 eruptions of Fagradalsfjall volcano, Iceland

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Geochimica et Cosmochimica Acta

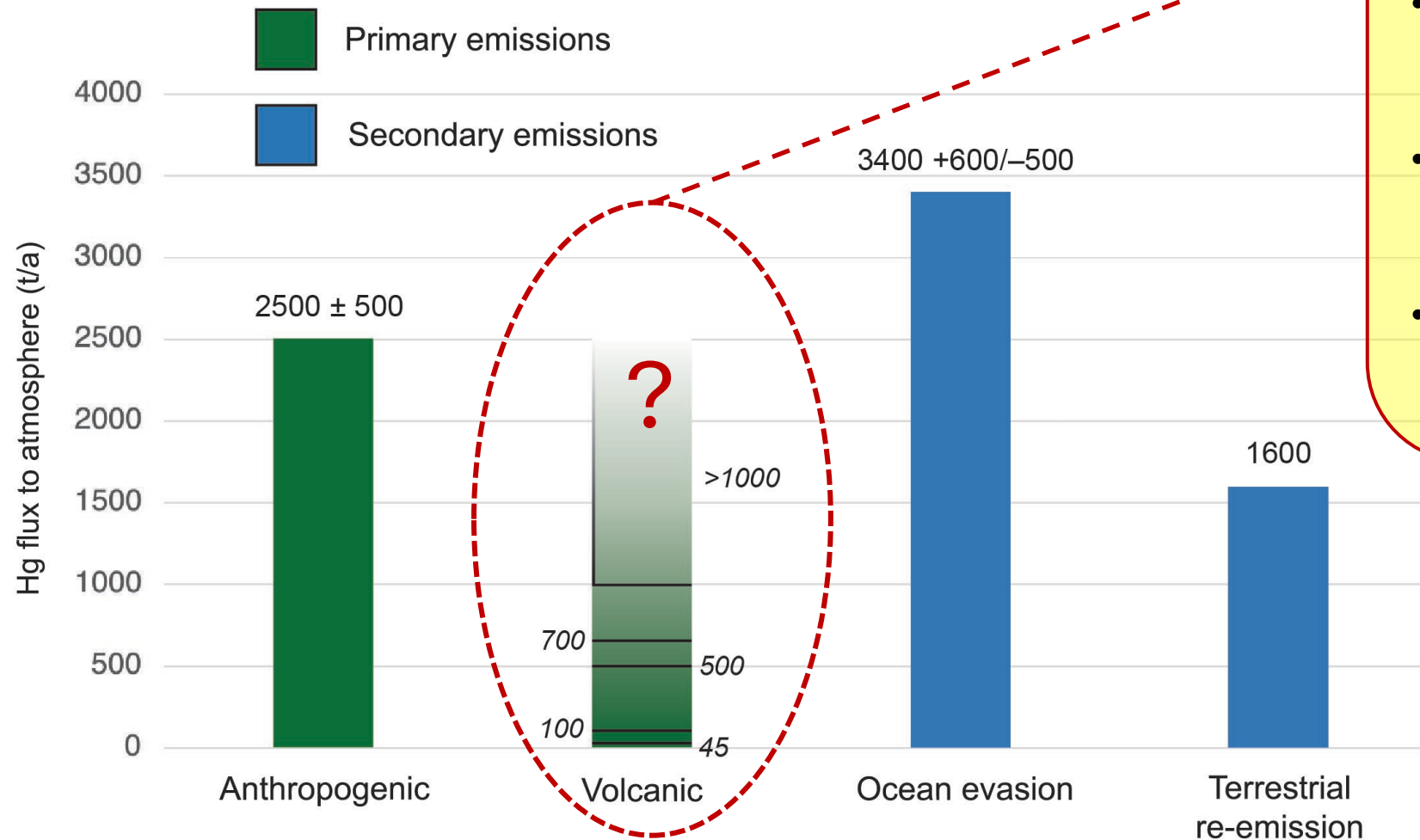
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Mercury from Icelandic geothermal activity: High enrichments in soils, low emissions to the atmosphere

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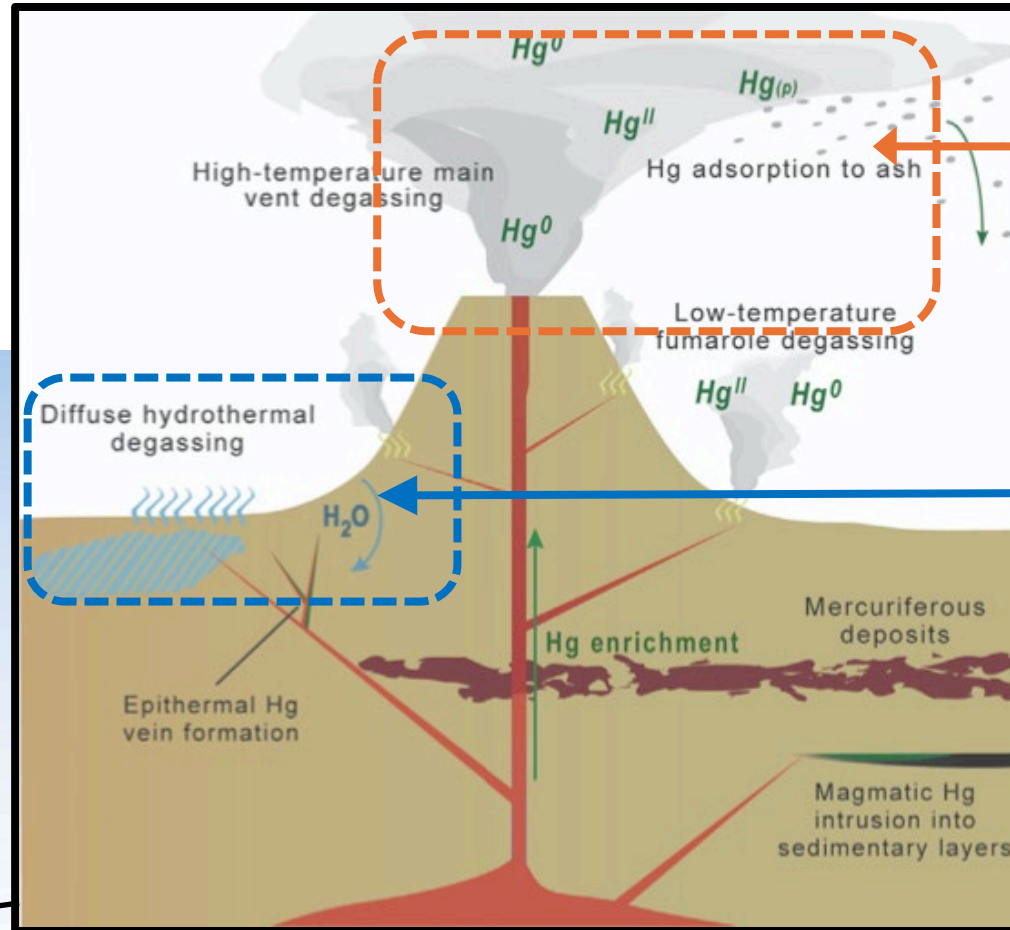
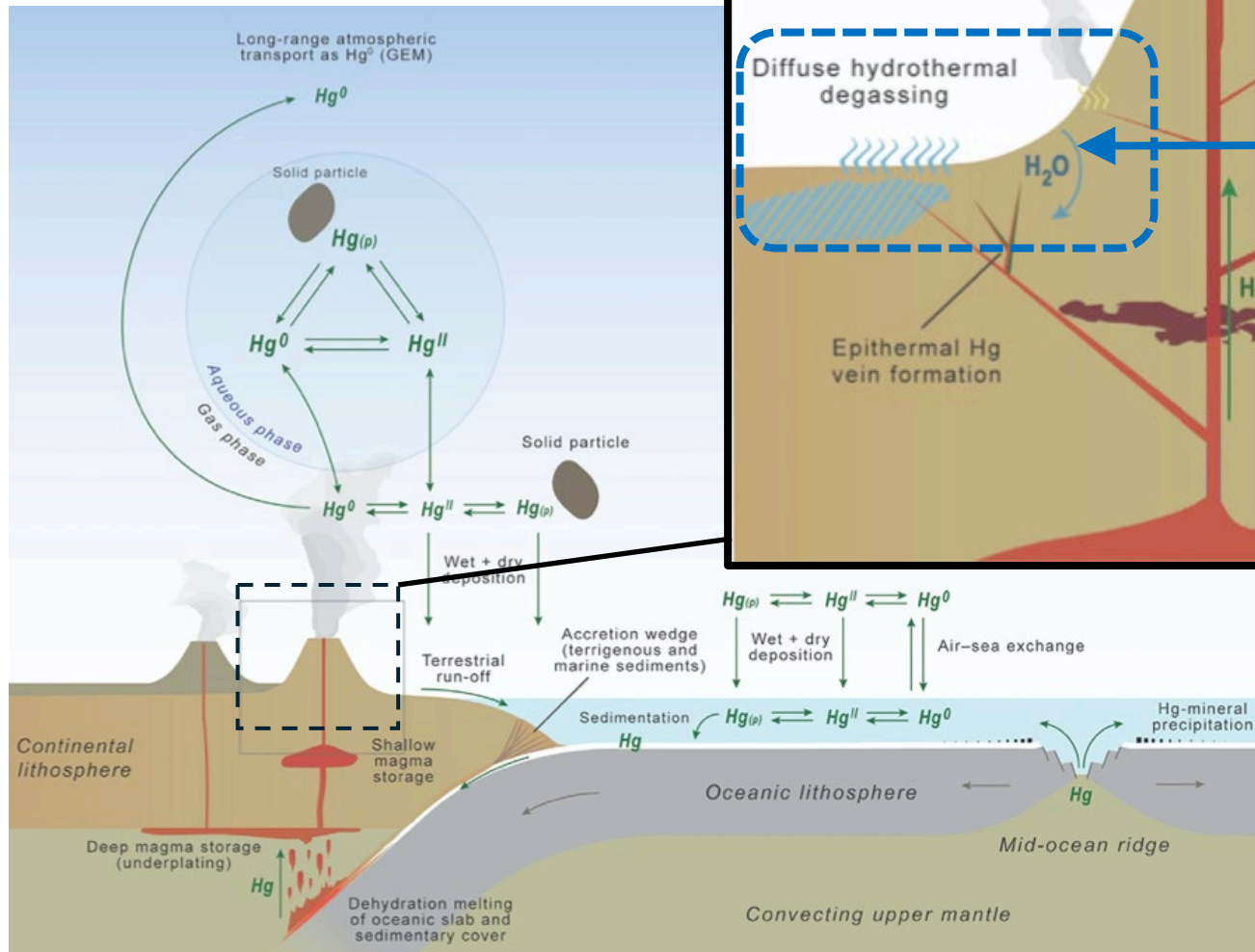
Global mercury emissions



Major uncertainties in volcanic Hg emissions:

- **Spatial:** small number of volcanoes/geothermal activity studied
- **Temporal:** No to very limited measurements during eruptions
- **Methods:** Reliability & suitability of measurement techniques

Hg Emissions from Volcanism



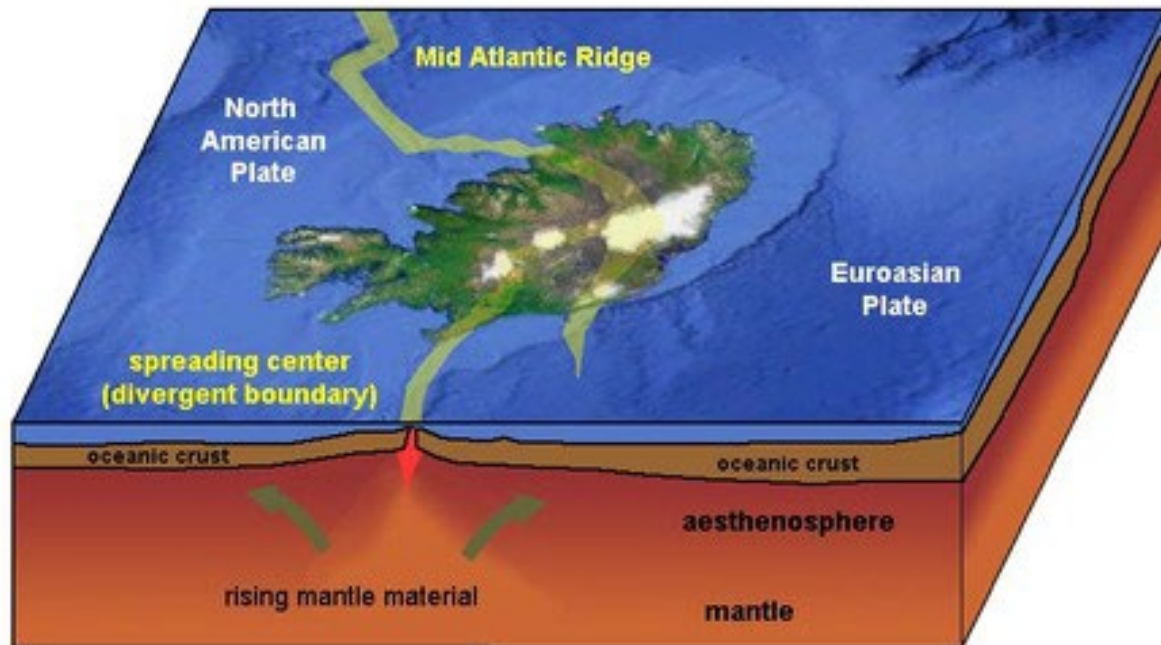
Eruptive Hg emissions?

Geothermal Hg emissions?

Edwards et al. (2021)

Why Iceland?

- Combined spreading ridge and hotspot tectonic setting
- Frequent eruptions & continuous geothermal activities
- No volcanic Hg data published in >30 yr



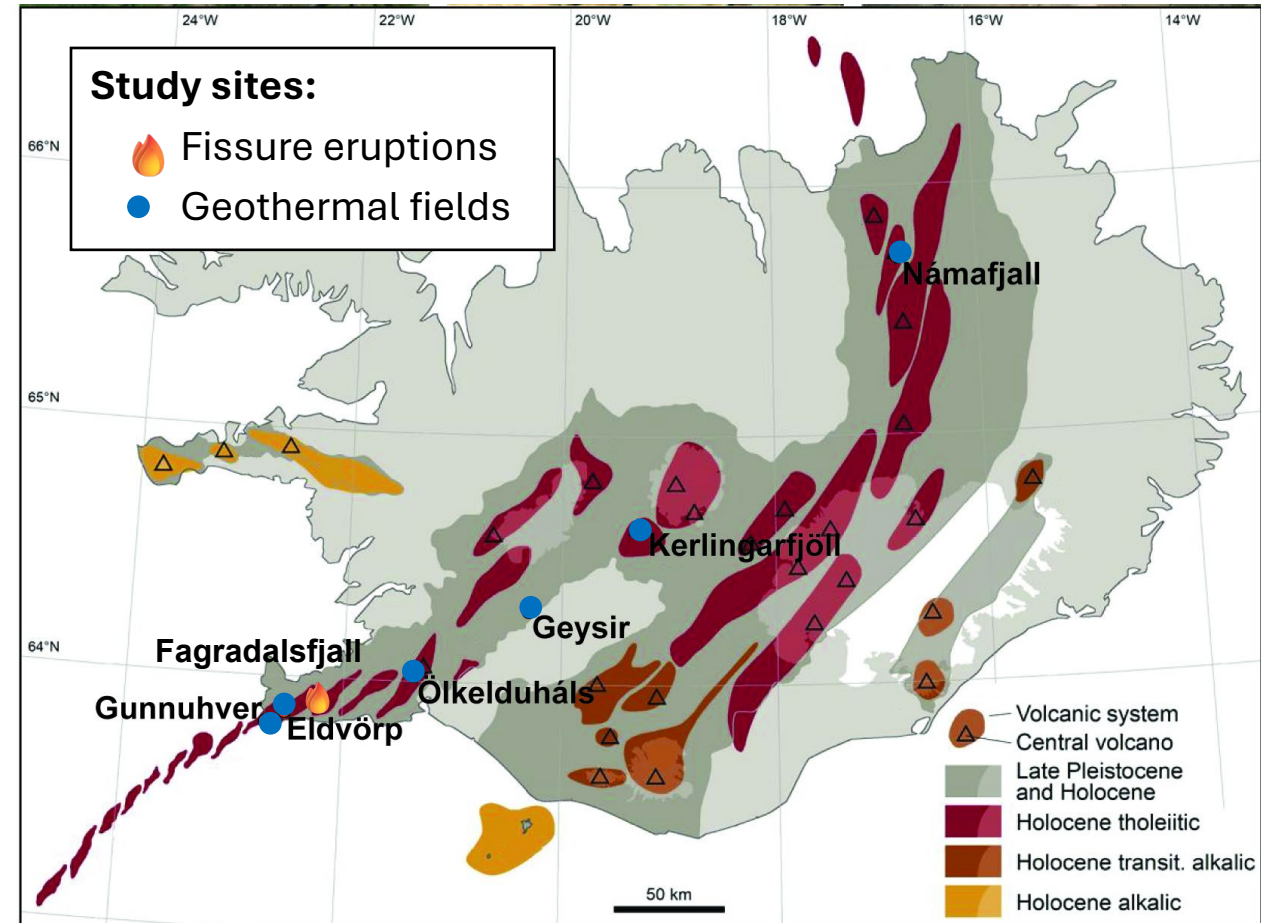
Our study

➤ Two fissure eruptions @ Fagradalsfjall:

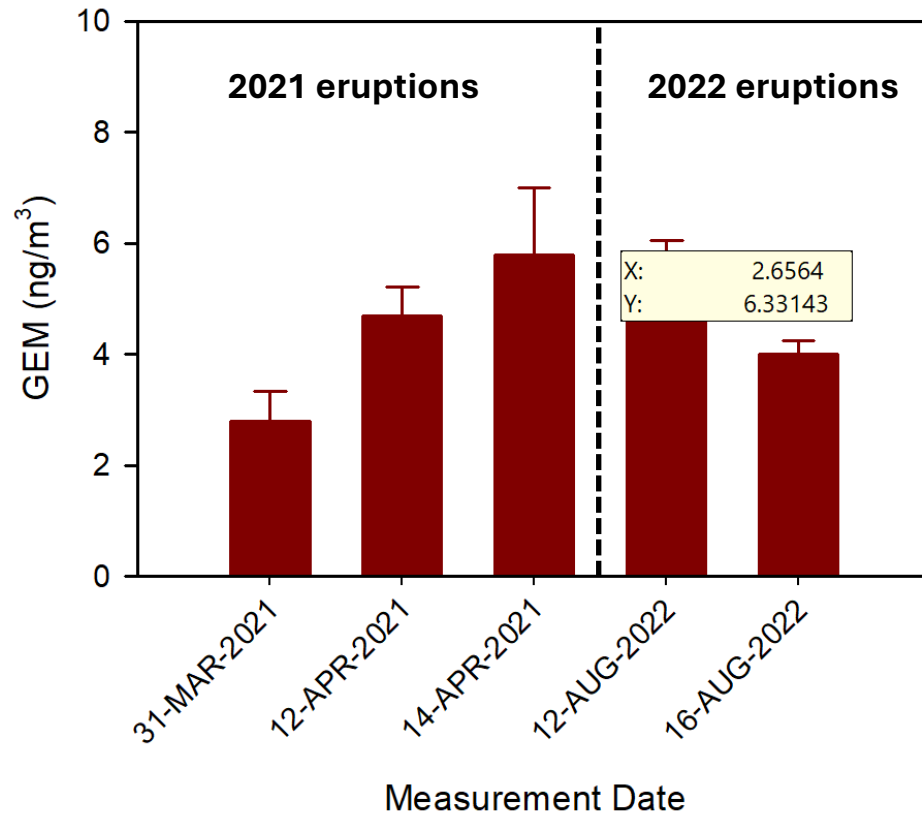
- ❑ April 2021
- ❑ Aug 2022
- ❑ Combined drone- & ground-based measurement by real-time Hg analyzers, & passive & active samplers

➤ Six geothermal sites:

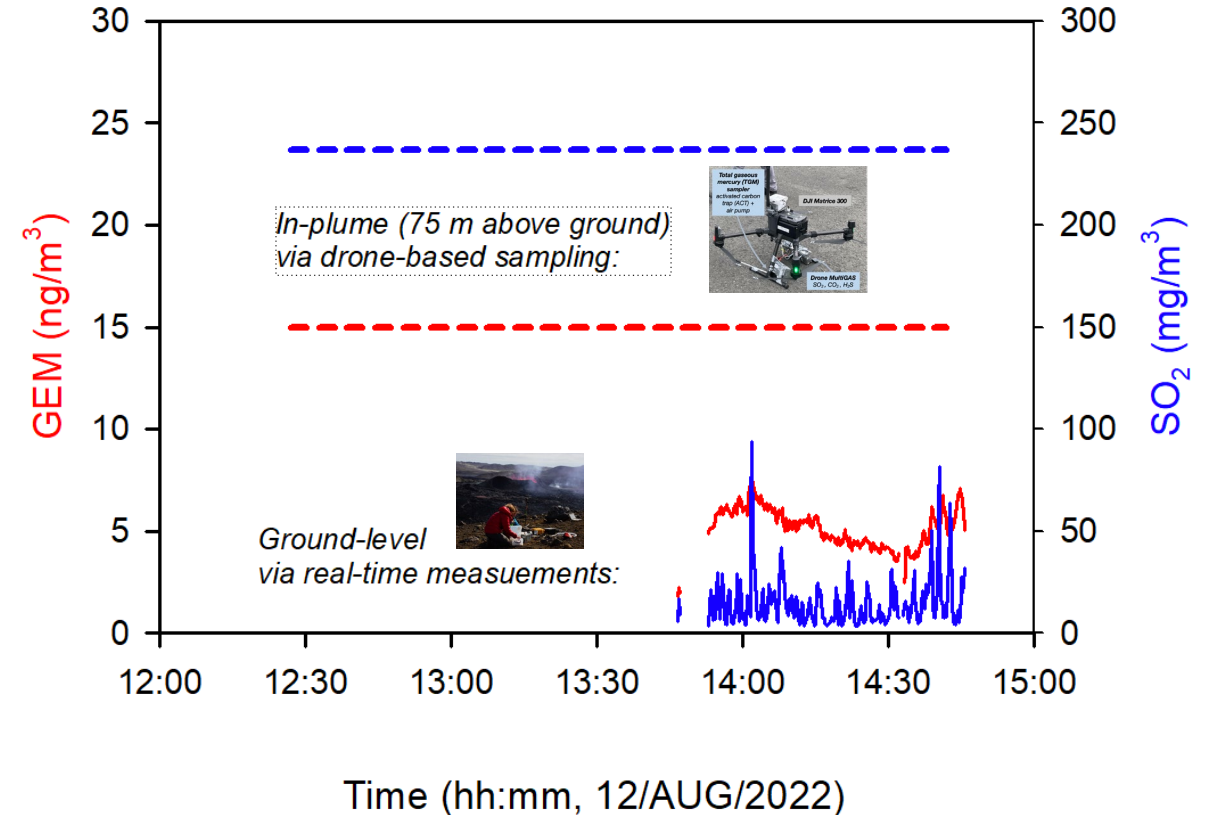
- ❑ High-density soil GEM @ 10 cm depth & THg for spatial variability in concentrations
- ❑ Paired soil GEM @ 1 cm and 10 cm depths for flux estimate



Hg from Fagradalsfjall eruptions: Exceptionally low concentrations & flux for any reported active eruptions (I)

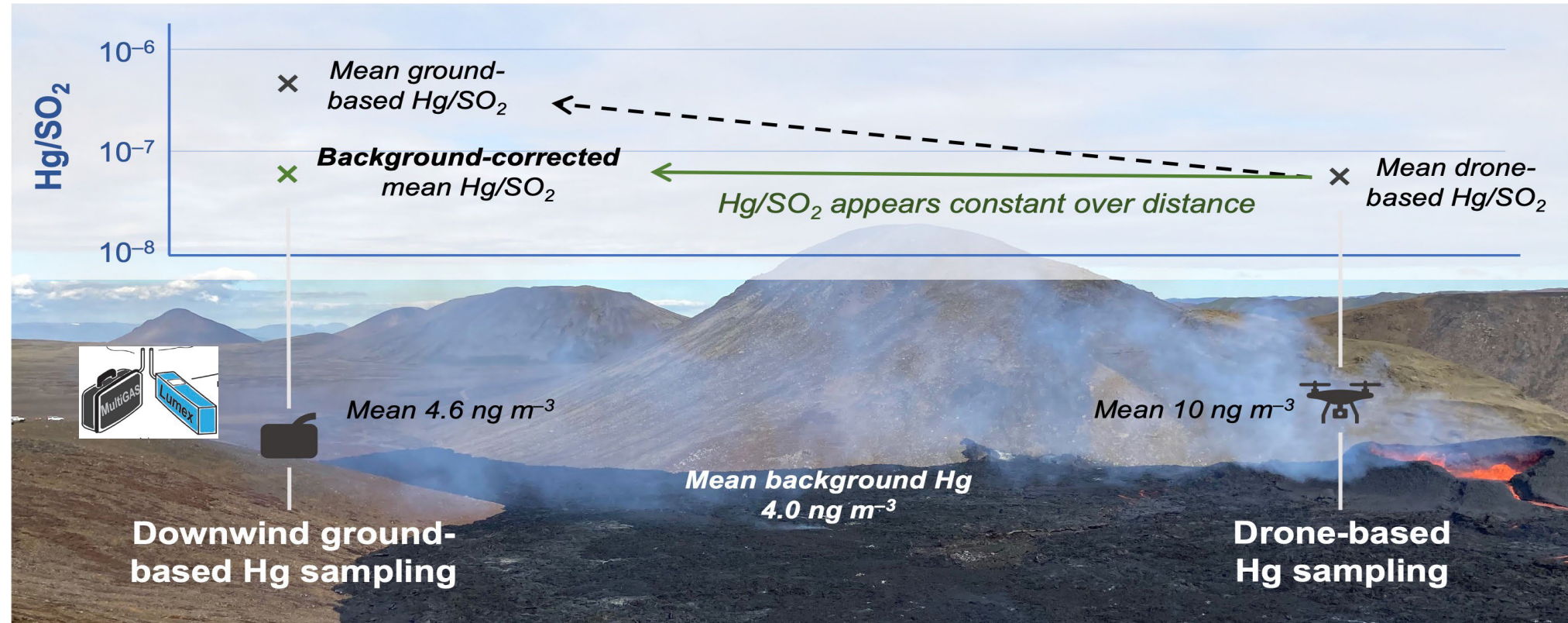


In plume Hg: ground-level during various phases of eruptions



In-plume Hg: ground level vs 75 m above

Hg from Fagradalsfjall eruptions: Exceptionally low concentrations & flux for any reported active eruptions (II)

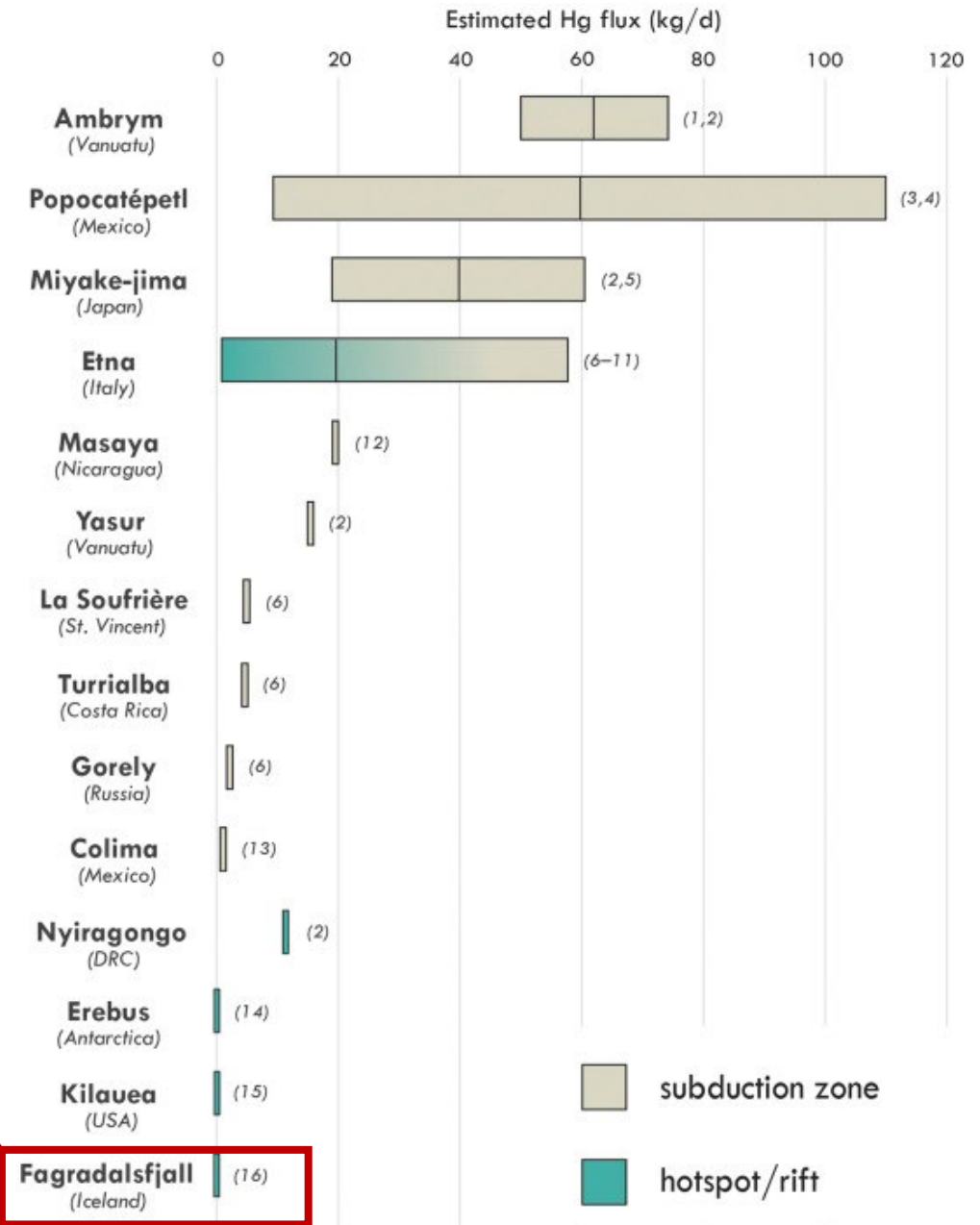


Hg/SO_2 mass ratio, **when corrected for background Hg**, appears near constant over several hundred meters

Hg from Fagradalsfjall eruptions: Exceptionally low concentrations & flux for any reported active eruptions (III)

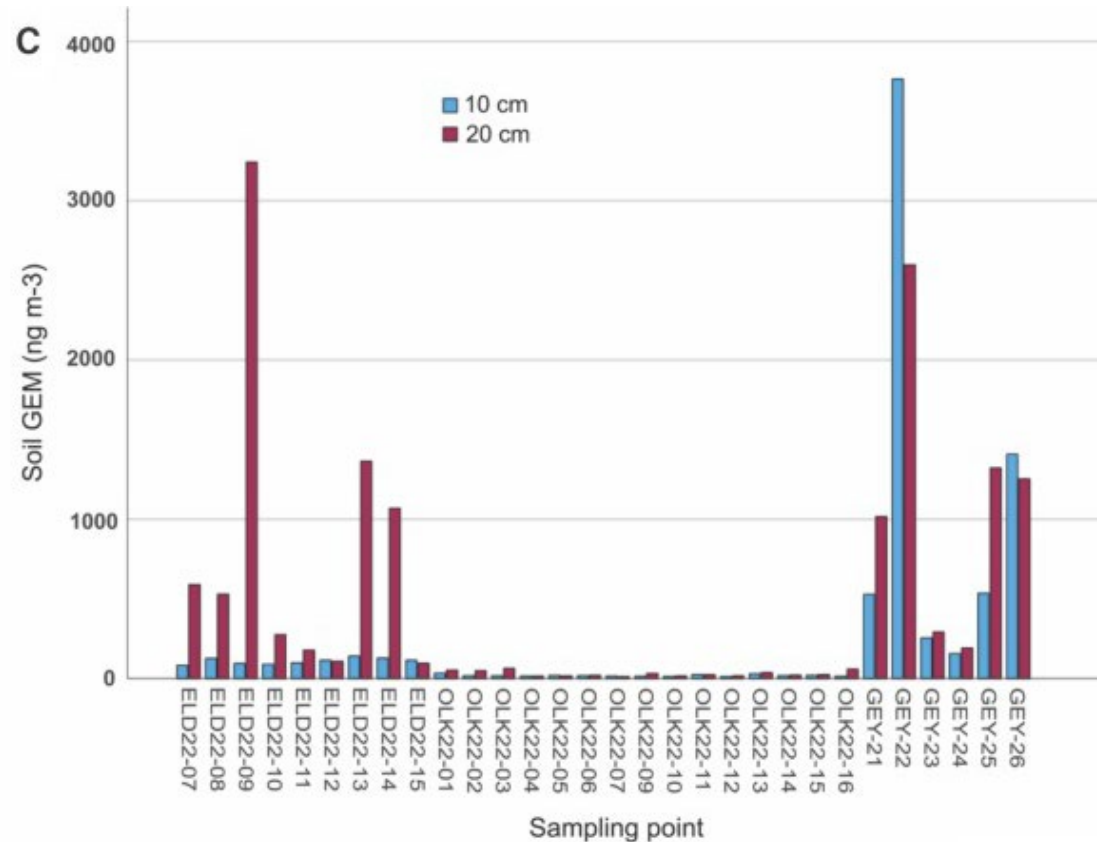
= 0.23 kg/d
= 46 kg over the 200-day eruptions
during 2021–2022 eruptions
= 84 kg/yr prorated for a year

Edwards et al., 2024, STOTEN



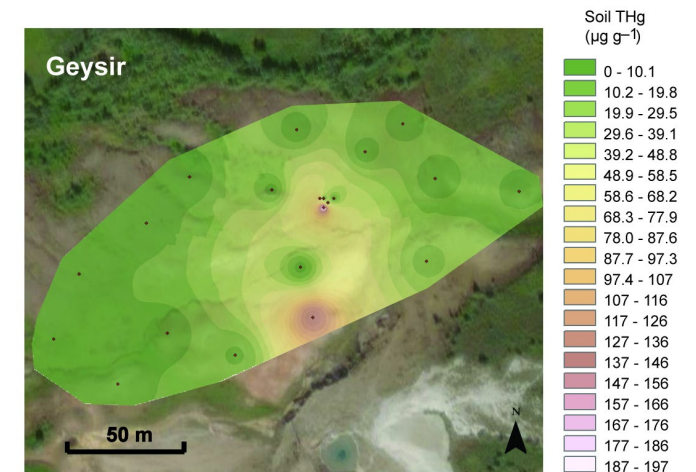
Geothermal activity:

High enrichment in soil, low emissions to the atmosphere (I)

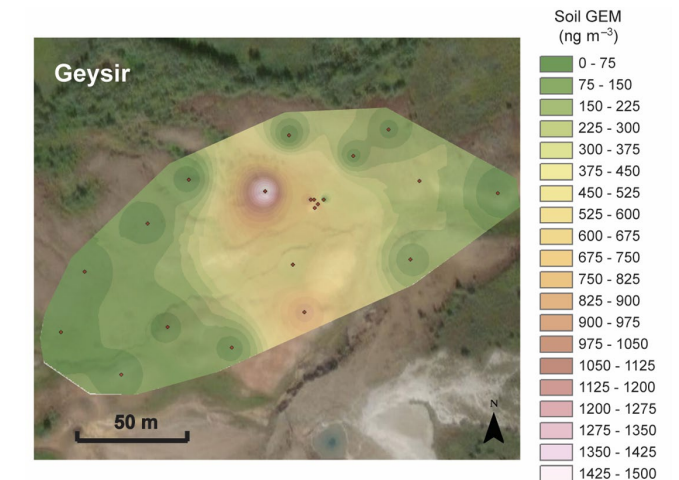


Edwards et al., 2024, GCA

Soil GEM
@ 10 cm



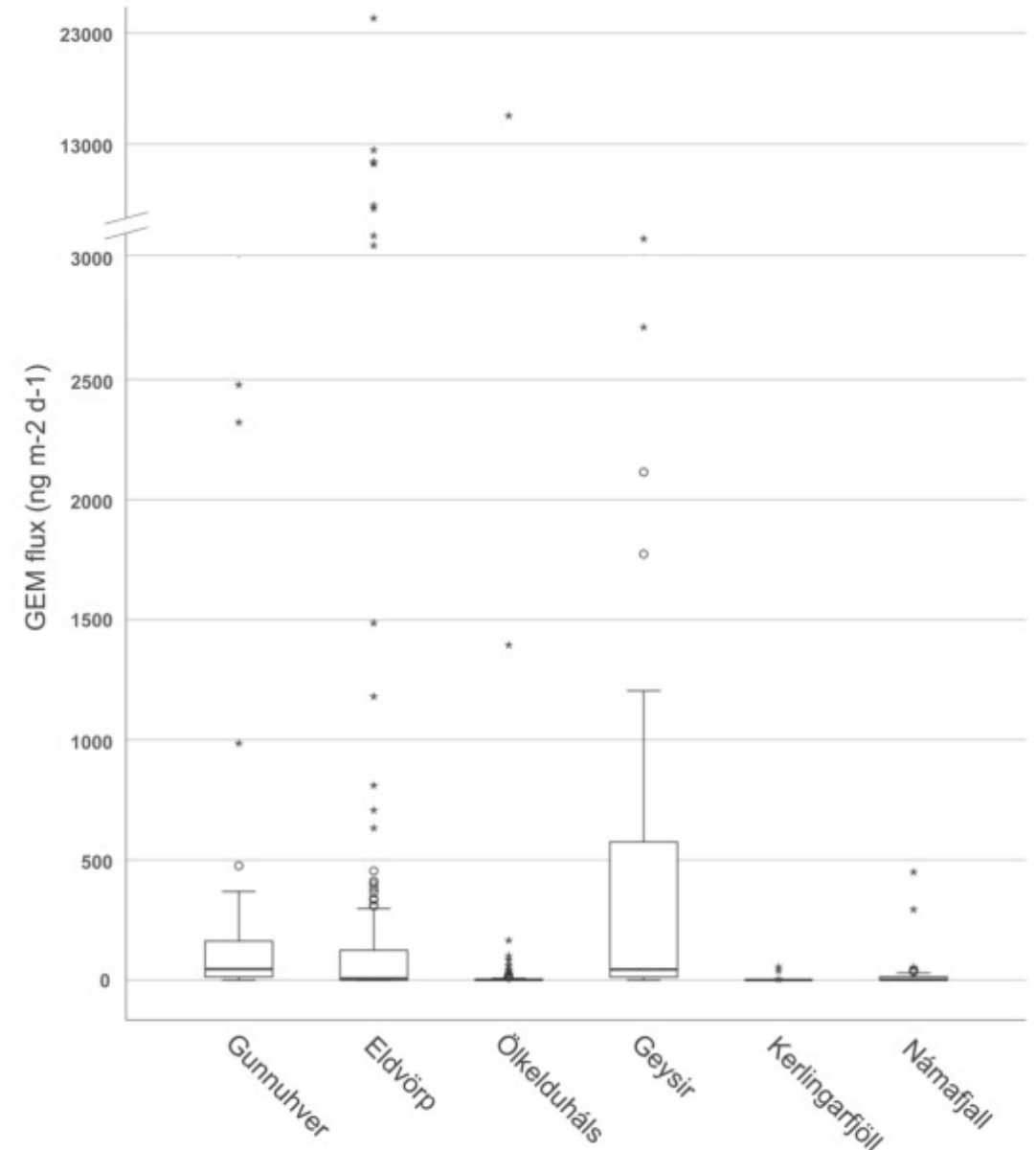
Soil THg



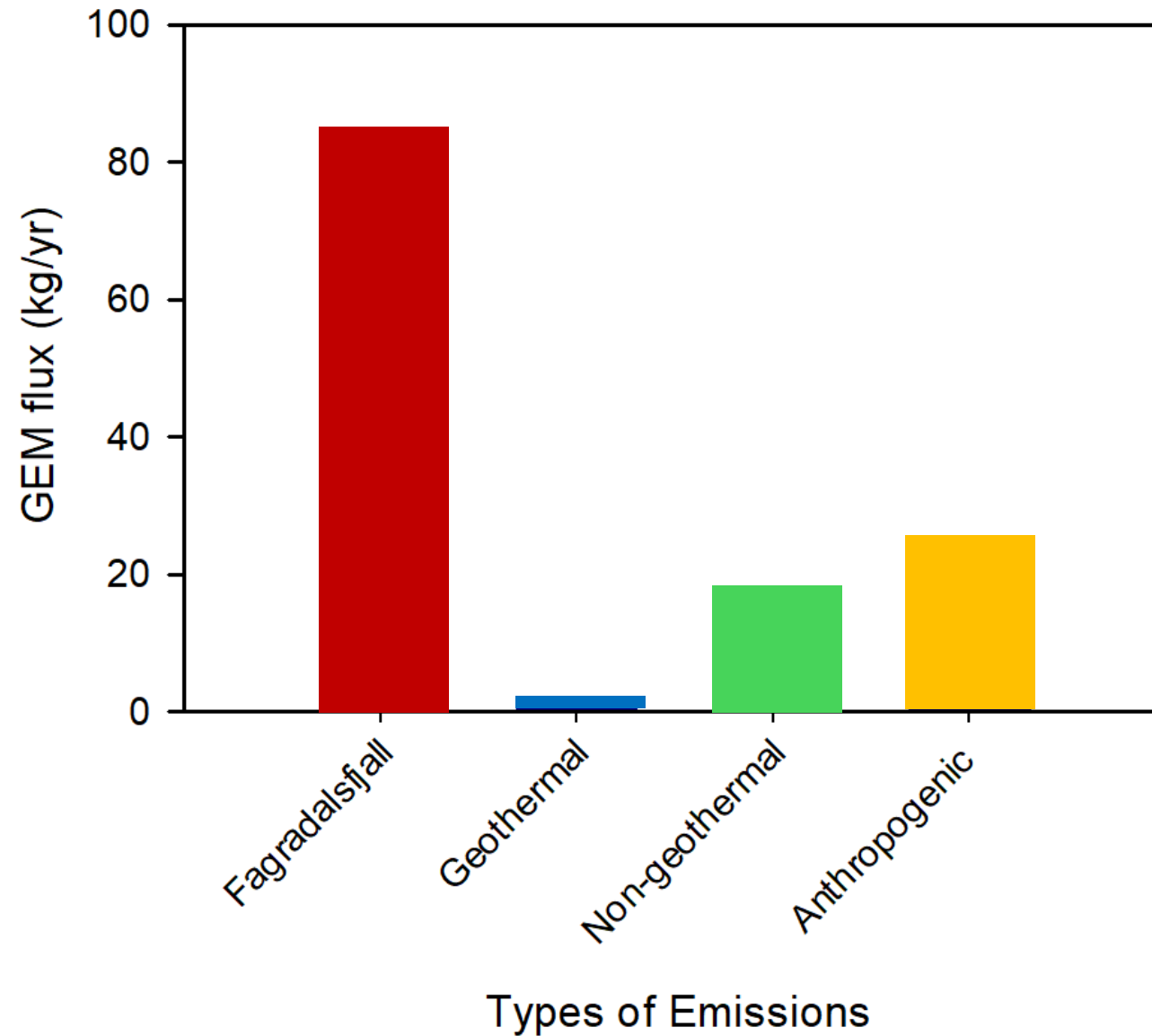
- Soil GEM: up to 19,000 ng/m³
- Soil THg: up to 200 μg/g, comparable to **heavily anthropogenically contaminated soils**

Hg from geothermal activity: High enrichment in soil, low emissions to the atmosphere (II)

- Total GEM flux from the 6 geothermal sites: 0.021 kg/yr
- Total flux to all Icelandic geothermal activity: 1.8 kg/yr

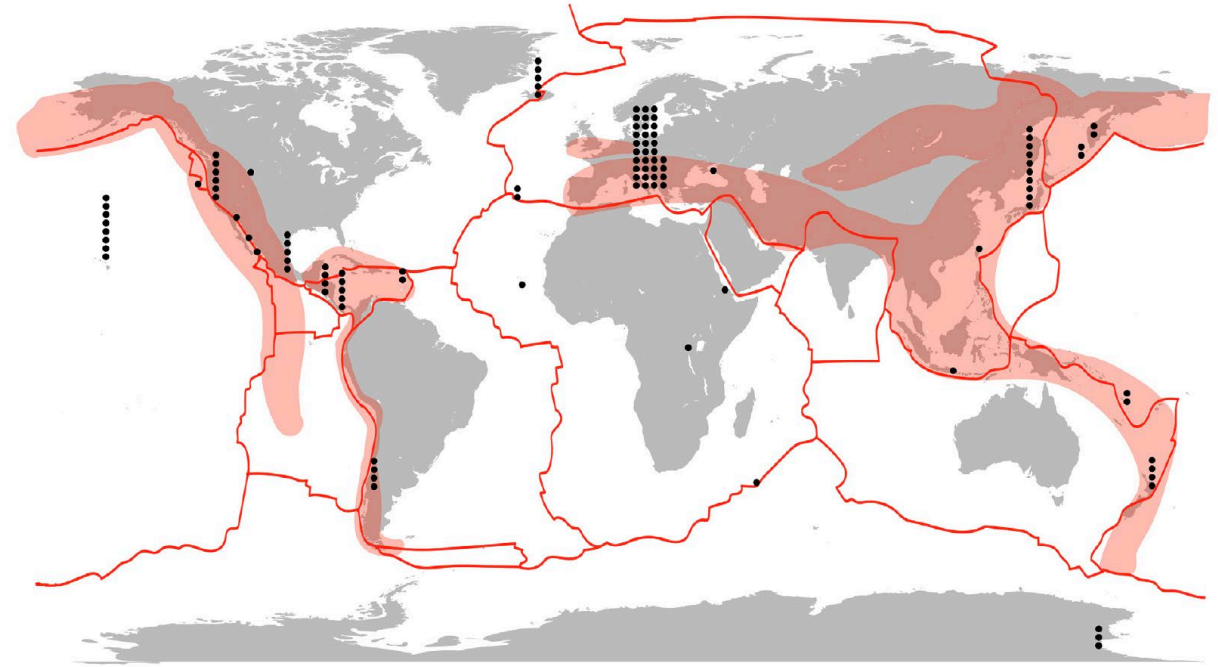


Summary of Hg Emissions from Iceland

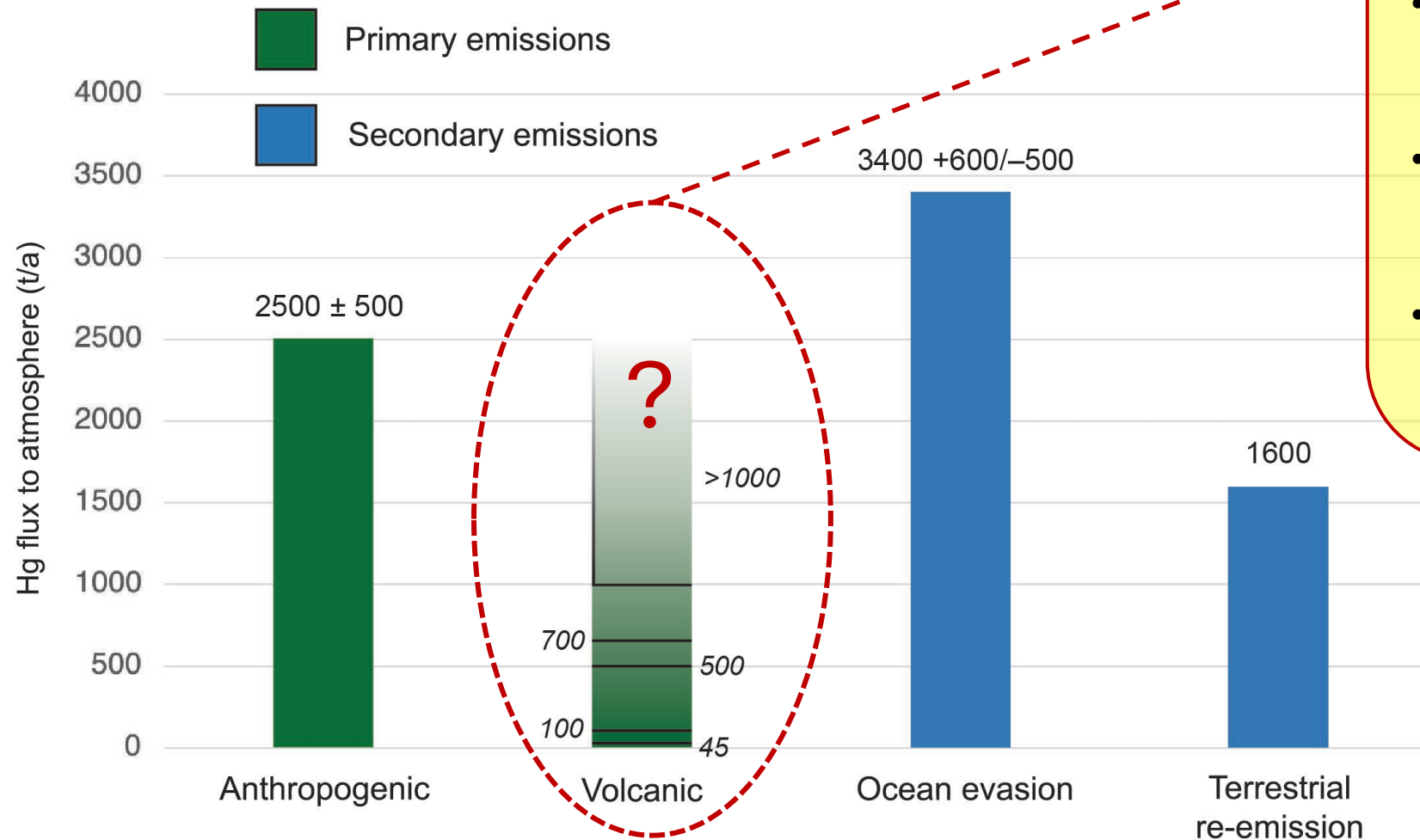


Why is Icelandic volcanism such a low Hg emitter?

- Mercury from volcanism is controlled:
 - ❑ **Mantle material** that feeds magma: relatively low Hg than crustal material
 - ❑ **Crustal material** that the magma “percolates” through: more enriched in Hg than mantle material
 - ❑ **Geotectonic processes** that influence where and how Hg is accumulated and remobilized
- **Arc volcanoes tend to be major Hg emitters:** they are formed above active subduction zones and older plate margins, where Hg is enriched due to ancient mantle degassing events and accumulation of crustal Hg in hydrothermal ore deposits.
- **Young, hotspot/rift volcanoes such as Icelandic ones, tend to be minor Hg emitters:** they are sourced from continual upwelling and decompression melting of mantle material that is relatively depleted in Hg



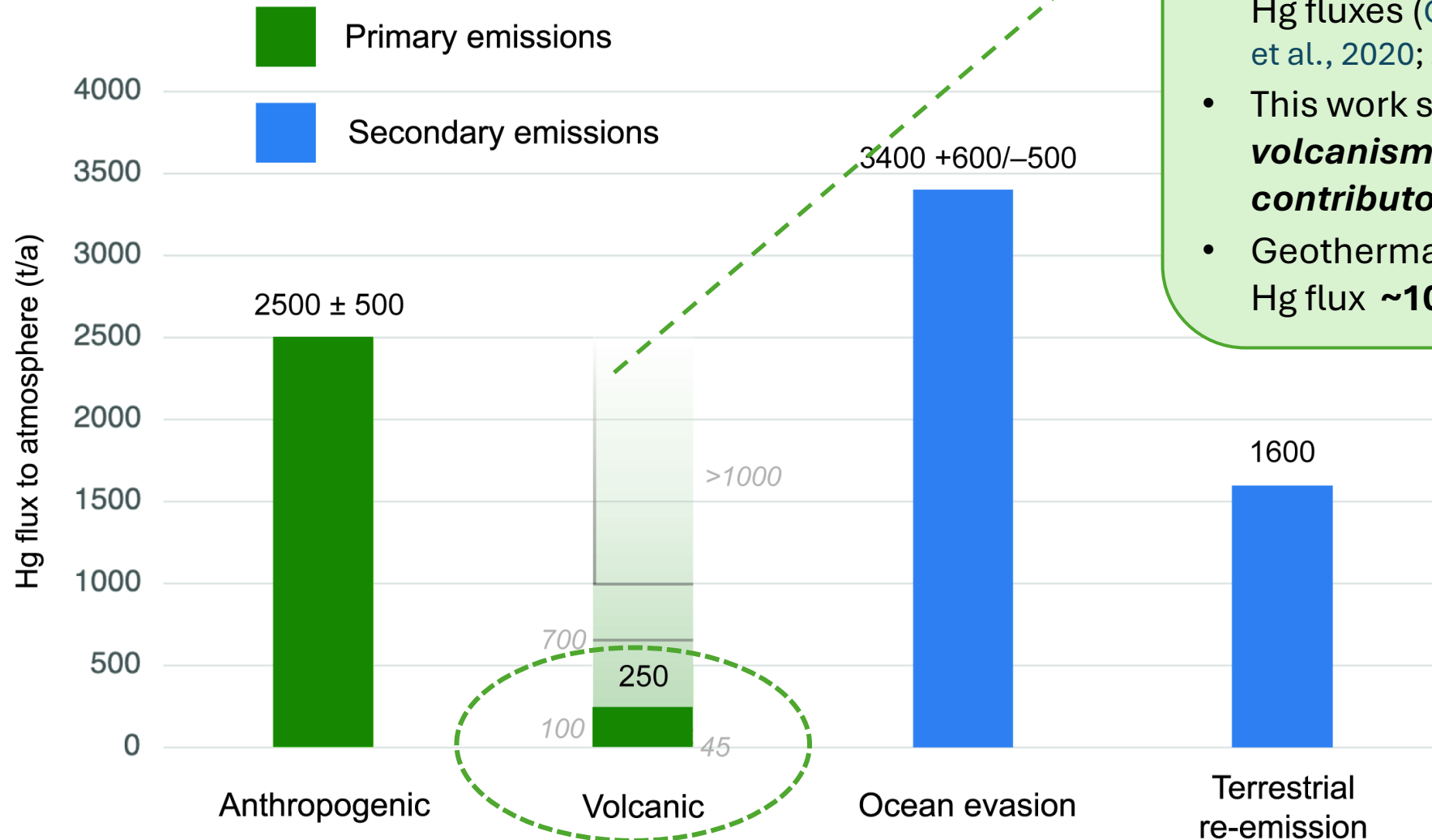
Back to global mercury emissions:



Major uncertainties in volcanic Hg emissions:

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Global mercury emissions, revisited



- Recent work has narrowed range of likely volcanic global Hg fluxes (Geyman et al., 2023; Li et al., 2020; Zhang et al., 2023)
- This work shows ***Iceland volcanism = likely very minor contributor to this total***
- Geothermal + fissure eruption Hg flux **~100 kg/year**

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