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EFFECTS OF LONG-TERM CLIMATE CHANGES AND GEOCHEMICAL PROCESSES ON MERCURY ACCUMULATION IN SOUTH AMERICAN AND AFRICAN MARGINS DURING THE LAST GLACIAL-INTERGLACIAL CYCLE

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Introduction

The accumulation of trace metals in environmental archives is controlled by climatic and geochemical processes. Mercury (Hg), a major global pollutant, is released into the environment via natural and anthropogenic sources. Being susceptible to long-range transport, it poses a threat to both human and environmental health. To understand how climatic and biogeochemical processes affect Hg cycling and accumulation in the environment, Hg profiles in environmental archives are studied. Here, we study mercury records from marine sediment cores GL-1248 and ODP1077 collected from the continental slope off northeastern Brazil, and the Congo deep-sea fan area respectively. Our objective is to gain insights into the dynamics of mercury accumulation in the African and South American continents (known t to be highly vulnerable to climate change), to climate forcing.

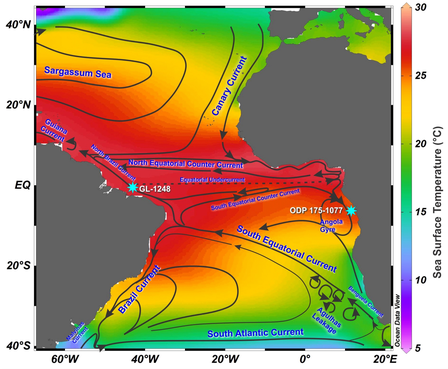

Fig. 1: Map showing the positions of the marine sediment cores GL-1248 (0°55.2'S, 43°24.1'W) and ODP 175-1077 (5°10.8´S, 10°26.2´E) used in this study. They are located on the continental slope of northeastern Brazil and the Congo deep-sea fan respectively. Also shown are surface currents including South Equatorial Current (SEC), North Brazilian Current (NBC), Brazilian Current (BC), South Equatorial Counter Current (SECC) and North Equatorial Counter Current (NECC).

Results and Discussion

GL-1248	ODP1077
• Parnaíba Basin area = 344, 000 km^2 • 4,400 km river length • Discharge volume = 1, 272 m^3/s	• Congo River basin area = 4, 014, 500 km^2 • 4,700 km river length • Discharge volume = 41, 200 m^3/s
• Average Hg concentration = 42.67 ng/g • Highest Hg concentration = 69.43 ng/g	• Average Hg concentration = 77.61 ng/g • Maximum concentration = 256 ng/g
Hg accumulation varied with **glacial/interglacial changes** and **millennial-scale events**	Hg accumulation varied with **changes in terrigenous material delivery** and **marine organic carbon production**
Hg concentrations in GL-1248 increased (decreased) with increasing (decreasing) **terrestrial material delivery (Fe/Ca)**	Hg concentration in ODP1077 increased (decreased) with decreasing (increasing) **terrigenous material influx (Fe/Ca)**
Mercury is strongly correlated with **XRF-Fe (R^2 = 0.74, p < 0.0001)** implies that Hg is Iron compounds are the major carrier phase of Hg to the sediment	Positive correlation between **Hg and XRF-Ca (R^2 = 0.505, p < 0.001)** suggests that Hg is scavenged and delivered to the sediment by marine organic matter

Results and Discussion

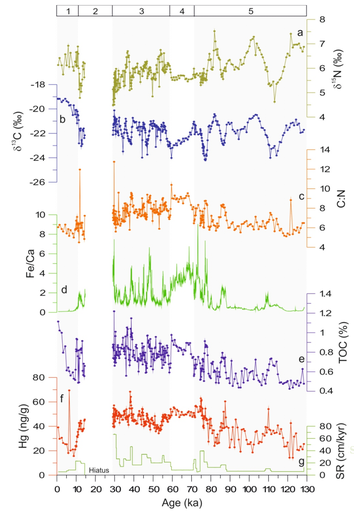

Fig. 2: Hg variation and paleoenvironmental proxies of the core GL-1248.

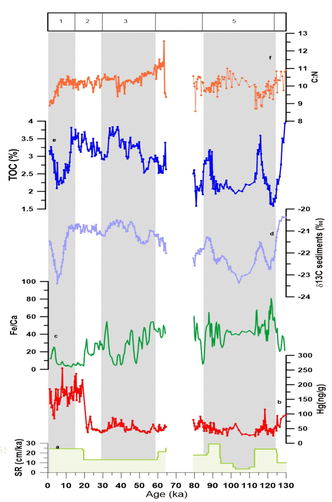

Fig. 3: Hg variation and paleoenvironmental proxies of the core ODP1077

PALEOCLIMATIC CONTROLS ON MERCURY DEPOSITION IN NORTHEAST BRAZIL SINCE THE LAST INTERGLACIAL

Origin and Geochemistry: Marine sediments accumulating offshore NE Brazil are sourced from the Parnaíba Basin (Lacerda et al., 2013), a region of no-Hg bearing geology (Lacerda et al., 2017). Thus, the atmosphere is the dominant source of Hg to the Parnaíba Basin. Post-depositional Hg geochemical process in South American soils suggests that Hg is better correlated with Iron (Fe) -oxyhydroxides than with organic matter (Oliveira et al., 2001).

Climatic processes: *Glacial-Interglacial climate variation Millennial-scale climate variability:*

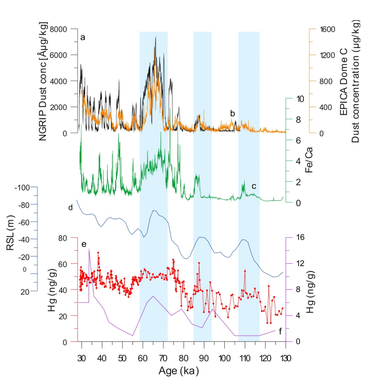

Fig. 4: Glacial-Interglacial controls on Hg concentrations.

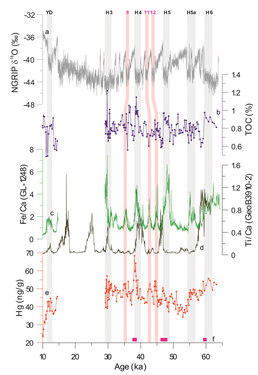

Fig. 5: Millennial-scale events recorded by Hg concentrations

Results and Discussion

MERCURY VARIATION IN THE CONGO AREA OVER THE PAST 130 ka

Origin:≥ 95% of sediment deposited in the deep-sea fan is directly provided by the Congo River, and aeolian contribution is limited Gingele et al. (1998)

Key features**:**

➢**High productivity region** as a result of **(i)** complex interaction of oceanic/river induced upwelling, and **(ii)** Nutrient supply by the Congo River.

➢**Changes in terrigenous sediment delivery:** During intervals of high terrigenous sediment delivery showed by significant Fe/Ca ratio, the total organic matter is diluted by the influx of terrestrial organic matter. Hg sequestration to sediments is preferentially executed by marine organic matter, thus, lower Hg concentrations are recorded during periods of elevated terrigenous sediment delivery. The reverse occurs in periods if low terrigenous sediment delivery.

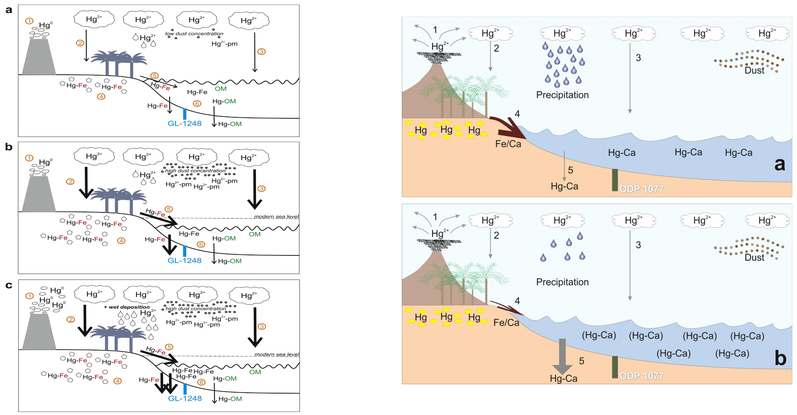

Fig. 6: Conceptualization of Hg dynamics in GL-1248 (left) and ODP1077 (Right)

Conclusions

- ✓ The marine sediment cores are directly under the influence of terrigenous material delivery from the rivers originating from their respective adjoining continents. However, the effects of terrigenous export signal on Hg accumulation in sediments are dissimilar.
- ✓ Likewise, the role of organic matter in Hg sequestration in both cores is different.
- ✓ The regional climate phenomena at GL-1248 can be said to be inadequate to completely mask global climate dynamics, whereas the global climatic conditions at the ODP1077 are completely obscured by the respective regional climate and its resultant effect on sediment delivery to the Congo deep-sea fan area.
- ✓ Finally, the evidence from this study show two different pathways by which mercury is incorporated into marine sediments for prolonged storage and inclusion in the global mercury biogeochemical cycle over the last glacial-interglacial cycle.

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