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Permafrost mercury stores and mobilization by riverbank erosion in the Yukon River Basin of Alaska

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Rapid warming in the Arctic threatens to destabilize the potentially large mercury (Hg) deposits contained within permafrost. Yet the amount of Hg in permafrost is highly debated, with estimates ranging widely. Moreover, how Hg will be released to the environment as permafrost thaws remains poorly known — leading to large uncertainty in the impact on water quality, human health, the environment, and the global mercury cycle. Here we present new measurements of Hg stocks in discontinuous permafrost in the Yukon River Basin in Alaska, and we explore the mobilization of this Hg via riverbank erosion. We collected riverbank and floodplain sediments near the villages of Beaver, where the river has many channels and a gravel bed, and Huslia, where the river is single-threaded with a sandy bed. To constrain total Hg (THg) stocks across the floodplain at each field site, we measured THg content, bulk density, moisture content, and particle size distributions from a series of exposed cutbanks and point bars. The results were mapped onto the floodplain deposit stratigraphy to calculate THg stocks. We then used these floodplain THg estimates and observations of river migration rates (derived from a combination of remote-sensing and radiocarbon data) to build a mass-balance model that captures the net balance of particulate THg erosional and depositional fluxes as river channels migrate at rates of meters per year. Constraining the net Hg flux within and out of Arctic rivers provides unique insight into the fate of Hg as permafrost thaws that is currently unconstrained.