Global-scale changes in Hg cycling during glacial-interglacial transitions

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Abstract

Records of Hg in ice cores from Dome C indicate elevated Hg deposition to Antarctica during cold periods (glacials, stadials) of the Late Quaternary [1, 2]. Hypotheses to explain this phenomenon ultimately center on coincident increases in deposition of soil dust (of South American origin). Vandal et al. [1] suggested dust-driven increases in productivity of the Southern Ocean resulted in increased oceanic Hg^0 evasion, whereas Jitaru et al. [2] argued cold conditions facilitated efficient scavenging of atmospheric Hg onto dust particles. We will present data from additional geologic archives (sediments, ice) that challenge these hypotheses and, further, indicate glacial-interglacial transitions resulted in global-scale changes in Hg cycling. A 40,000-year sediment record from Lake Titicaca (Bolivia/Peru) (corrected for detrital Hg inputs) shows elevated Hg deposition during the Last Glacial Maximum – in remarkable agreement with the extent and timing of the Dome C record. However, there is not enough Hg in the atmosphere and surface ocean even today that could be redistributed to account for the absolute increase in deposition to Lake Titicaca. An additional source of Hg to the system is required, and one possibility is the massive reservoir of Hg in the solid earth. Volcanism was initially dismissed as a source of Hg to Dome C, based on an inadequate amount of non-seasalt sulfate in glacial ice to explain Hg increases [1, 2]. During the Last Glacial Maximum, however, lowered sea level could have acted to depressurize shallow volcanic and hydrothermal systems, encouraging greater activity [3]. Submarine volcanism would add Hg to the ocean, which could later be mobilized to the atmosphere, decoupling it from sulfate and other non-volatile tracers of volcanic activity. We will explore this hypothesis by constraining Hg fluxes from submarine volcanism during glacial and interglacial periods, as well as by comparing the records from Dome C/Lake Titicaca to other Late Quaternary records (reconstructions in progress for GISP-2, Cariaco Basin, Lake Baikal). This work may provide the basis for using Hg as a paleo-proxy of large-scale geophysical/climate change.

[1] Vandal et al. (1993) *Nature* **362**, 621-623. [2] Jitaru et al. (2009) *Nature Geoscience* **2**, 505-508. [3] Huybers and Langmuir (2009) *EPSL* **286**, 479-491.

Construction of a Fully Searchable Soils Database Integrating Soil Characterization Data and Whole-Soil Geochemical Data

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Paleopedological studies rely heavily on the use of contemporary soil characterization and whole-soil geochemical data [1, 2, 3]. These soil science resources serve the needs of paleopedologists who reconstruct ancient climate and soil systems using models to relate modern physical/chemical soil characterization data, whole-soil geochemical data, and climate parameters [3, 4, 5]. The (paleo)pedologist currently faces a “data overload” problem due to a number of global and continental-based soil geochemical databases becoming widely available. The overwhelming nature of the available data makes model construction difficult and time-consuming. The emerging field of data analytics addresses the overload problem by providing a systematic process for data acquisition, cleaning, initial analysis and main analysis. We used a data analytics approach to construct the Baylor Paleosol Informatics Cloud (BU-PIC). The BU-PIC uniquely combines: (1) USDA-NRCS pedon data, (2) PRISM-based climate parameters, (3) NLCD land-cover attributes, and (4) published paleosol data. This aggregation of data will allow paleopedologists to upload standardized geochemical data and test and refine soil-derived paleoclimate proxies and paleopedotransfer functions. Although BU-PIC development is in the initial stages of data cleaning, preliminary analysis shows promising results. For example, variations in whole-soil weight % Fe_2O_3 explain approximately 76% of the variance in % Fe_d (pedogenic iron) in all soil horizons spanning 4000 pedons, and variations in whole-soil weight % CaO explain approximately 86% of the variance in $CaCO_3$% in 865 pedons (A and B horizons only, no gypsum). This may be useful for paleopedologists interested in determining the amount of pedogenic iron and pedogenic carbonate within a lithified paleosol. Binning by specific soil orders and soil textural classes suggests that proxies can be improved by separation rather than aggregation seeking “universal” proxies. We believe the success of BU-PIC will rely on building rapport with modern soil scientists while seeking their consultation during the developmental stages. [1] Sheldon, Retallack & Tanaka (2002), *Journal of Geology* 110, 687-696. [2] Driese et al. (2005) *Journal of Sedimentary Research* 75, 339-349. [3] Nordt & Driese (2010), *Geology* 38, 407-410. [4] Nordt & Driese (2010), *American Journal of Science* 310, 37-64. [5] Nordt, Dworkin & Ashley (2011) *GSA Bulletin* 123, 1745-1762.