Lacustrine sedimentary evidence of millennial scale variability in North America and Africa revealed by XRF core scanning

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Evidence of millennial scale variability during glacial periods is present in a growing number of climate archives from across the globe. We present XRF scanning results that suggest that such variability, possibly linked to global processes, has been recorded in tropical and subtropical lacustrine sediments from Lake Malawi (East Africa), Lake Chalco (Mexico) and Valles Caldera (New Mexico, USA) during MIS 3-4, MIS3, and MIS12, respectively. Although the geochemical signal in each system differs, and rigorous chronological control cannot always be achieved in lacustrine sediments, all three records are consistent with northward shifts of regional climate systems during northern hemisphere interstadials. For example, in the region of Lake Malawi active volcanism occurs only to the north of the lake, so material borne by northerly winds has a distinctive chemical signature. Malawi sediments thus record shifting provenance of terrigenous minerals, as changes in ITCZ position strengthens or weakens northerly winds in concert with DO interstadials and stadials. At Valles Caldera, northward shifts of westerlies likely occured during warmer episodes. This appears to have induced aridity, allowing winds to mobilize and transport chemically altered minerals—perhaps from abandoned alluvial plains—to the lake. Finally, at Chalco times of Northern Hemisphere warming appear to coincide with humid conditions, presumably linked to increased North American monsoon strength. In closed basin lakes, such as Chalco, greater rainfall can lead to increased deposition of carbonates due to greater riverine delivery of calcium.

Application of a depositional facies model to an acid mine drainage site

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We analyzed the aqueous chemistry, mineral precipitates, microbial communities, and Fe (II) oxidation rates at an acid mine drainage (AMD) site in the context of a depositional facies model. Both pool and terrace facies at two locations on a natural iron mound were studied. Fe (III) precipitates were determined to be schwertmannite with pin-cushion morphology at all locations, regardless of facie. Microbial community composition was studied with 16S rDNA cloning and fluorescence *in situ* hybridization (FISH) and found to transition from a Betaproteobacteria and Euglena dominated environment at the AMD spring to an *Acidithiobacillus* dominated environment downstream, as pH decreased. Microbial composition at adjacent pool and terraces was similar; thus, microbial community structure was a function of pH and other geochemical gradients rather than facie. Surface-area normalized rates of Fe (II) oxidation measured in laboratory reactors ranged from 0.63 to 1.75 x 10^{-9} mol L^{-1} s^{-1} cm^{-2} and the fastest rates were associated with pool sediments. Sediments collected closer to the AMD spring were more efficient at Fe (II) oxidation than sediments collected further downstream, regardless of facie, suggesting that Fe (II) oxidation rates were also dependent upon geochemical conditions, not solely on the depositional environment. Sediments were irradiated with ^{60}Co and analyzed again to determine abiotic Fe (II) oxidation rates. No change in Fe (II) concentration was observed for sterilized sediments, indicating that all Fe (II) oxidation was a result of biological processes. A depositional facies model explained some differences in Fe (II) oxidation kinetics, but could not fully explain differences in water chemistry, mineral composition, crystal morphology, or microbial community composition.