Impact of anthropogenic bioturbation on nutrient chemistry of a small urban pond

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We characterized the impact of episodic anthropogenic bioturbation on the chemistry of Mirror Lake on The Ohio State University campus. Mirror Lake was formerly a natural water body, but is now an engineered structure. Water level varies from ~1 m (east side) to 2 m (west side) deep, is maintained by inflow from a fountain on the east side and outflow from a small stream on the west side. Total volume of the lake is ~2600 m^3. In late November, the undergraduate students have a tradition of rallying to support the Ohio State football team in their upcoming game against the University of Michigan by jumping into Mirror Lake. This event occurs annually, two nights before the big game, and lasts for several hours. Water samples were collected at two locations before, during, and after the event in November 2008 and 2009. Water samples were filtered and then analyzed for major ions using a Dionex ion chromatography and nutrients (TN, NH_4^+, NO_2^- +NO_3^-, TP, PO_4^{3+} and Si) using a Skalar nutrient analyzer.

The major element concentrations were similar on the east and west sides of the lake over the two years. The baseline nutrient concentrations varied between the two years, however, the trends observed during the disturbance were similar. The total phosphorus (TP) and PO_4^{3-} varied between the two years, ~400 ppb TP ~300 ppb P as PO_4^{3-} in 2008, and ~1000 ppb TP, ~500 ppb P as PO_4^{3-} in 2009, however, phosphorus concentrations did not change during the disturbance. The initial total nitrogen (TN) concentration was ~400 ppb N and was composed of ~80% organic N compounds. TN increased ~2-fold in 2008, and 5-fold in 2009 in the shallow (east) side of the lake over several hours associated with the big jump-in. Ammonia concentrations increased ~10-fold and 50-fold. There was little change in inorganic and total N concentration on the deep side of the lake during the disturbance, however, by the next day concentrations were equal on the east and west side, indicating that the lake was well mixed. Overall TN in the lake increased 50% in 2008, and doubled in 2009 over a 12 hour period.

Ocean $^{10}Be/^{9}Be$ evidence for stable weathering rates in the last 10 My explains constant atmospheric CO_2

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A five-fold increase of mountain erosion as suggested for the last 5 Million years from a global compilation of sedimentation rates [1] was not accompanied by a similar concomitant decrease in atmospheric CO_2 even though silicate weathering and physical erosion are tightly interlinked [2]. Using marine records of the isotopes of Beryllium we suggest that this increase may have never taken place. Be-10 is a rare radioactive cosmogenic nuclide, is produced mostly in the atmosphere and introduced to the surface oceans with a flux that can be considered to be globally uniform when averaged over time scales exceeding those of climate cycles. Be-9, in contrast, is stable, and enters the oceans from the continents mainly by river particulates and in the dissolved form. Over the past 10 My, records of chemical marine deposits (Fe-Mn crusts and authigenic deep sea sediments) show no change in the $^{10}Be/^{9}Be$ ratio. Therefore, these records support the hypothesis that global erosion and weathering fluxes were constant.

One possibility is that the increase in Neogene sedimentation rates is an artifact introduced by the discrepant time scale over which sedimentation is measured. The older the age, the longer the observational integration time will be, which in turn include longer periods of hiatus, and hence decreasing sedimentation rates with geologic time [2]. An analysis of the global and marine sedimentation rates surrounding the Himalayas and the Alps for time scale bias indeed suggests that erosion in these mountain belts might have been constant throughout the Neogene.

If this hypothesis is true, neither Late Tertiary mountain building nor Quaternary cooling affected or was affected by a change in silicate weathering rates. Instead, a more continuous mechanism such as subtle ongoing hillslope rejuvenation in any soil-mantled hillslopes in kinetically-limited settings enable the feedback that stabilizes atmospheric CO_2 levels through silicate weathering. Or, silicate weathering may still take place within the adjacent sedimentary basins, and large carbon deposits could also be buried there in the organic form.

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