Evaluating environmental response trends using an integrated paleolimnological approach

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We examine the hypothesis that ecosystems highly perturbed by human activities cannot return to their original unperturbed state and with the influence of climate change, new ecosystem balances are obtained. A problem is that ecosystems are perturbed by various stressors that operate at different timescales and intensities. Our approach is to integrate observations of various ecological/environmental indicators over time. An investigation of lacustrine sediments was used to examine this hypothesis and determine rates of response and recovery from environmental stressors.

The study area is Muskegon Lake (Great Lakes region, USA) which is in a watershed highly perturbed by human activity since the early 1800s. Logging, dams, agricultural runoff, urbanization and industry have resulted in altered hydrology, disrupted biological communities and chemical contamination. Sediment were analyzed for vertical profiles of pollen stratigraphy, diatom community structure, ^{210}Pb activity (sedimentation rates, age, focusing), and corresponding geochemistry that includes a suite of elements including trace metals and nutrients.

Three distinct paleoecological phases are represented in the sediment geochemistry chronology and diatom community structure of the core. Select relationships observed include: 1) Top section (<16cm depth) shows diatom species indicative of high nutrient conditions, specifically, *Achnanthidium minutissimum* and *Amphora pediculus*, which correspond to increasing phosphorus concentrations near the surface; 2) The 60 – 90cm depth reflects an increase in *Cocconeis placentula* and *C. placentula v. euglypta*, that predates the peak in anthropogenic loading of lead and mercury, after which, both species decline; 3) Bottom of core (>100cm depth) is abundant in *Cavinula scutelloides*, benthic diatom species associated with cooler climate (Little Ice Age), *Ophephora martyi*, and geochemistry that reflects apparent background conditions. Preliminary results are consistent with the hypothesis and are interpreted to indicate that ecosystems will work to attain new balances in the Great Lakes region as climate changes, but the magnitude of human disturbances further influences these new balances. It is hoped that this integrated approach will facilitate not only a better understanding of ecosystem response to stressors, but also a more realist assessment of new states of balance after the stressors are removed.

LIBS analysis of gem beryls: Single-pulse, double-pulse, and provenance determination

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Laser-induced Breakdown Spectroscopy (LIBS) is an attractive emerging tool for chemical analysis, including potential for real-time, in-field, minimally destructive analysis. LIBS is simultaneously sensitive to all elements, especially for those with low atomic weights. Based on the premise that every material produces a unique broadband LIBS emission spectrum, averaged LIBS spectra (200-980 nm) were collected for a wide variety of samples of the cyclosilicate gem beryl ($Be_3Al_2Si_6O_{18}$). Spectra were collected for single-pulse LIBS in air and Ar atmospheres, and for double-pulse LIBS in air. A methodology for comparing spectra was developed to determine provenance of gem beryls based on the premise that specimens from the same mine, mine field, or tectonic region should share a common geochemical signature. Analysis of over one hundred beryls from 27 localities world wide demonstrates that this should be possible, given the appropriate database. However, ionic substitutions in beryl are sufficiently complex that within-pegmatite variations controlled by magmatic differentiation and subsequent recrystallization add a significant amount of chemical variability to the beryls. Despite this complexity, the analytical and data processing protocols demonstrate that the provenance of beryls can be successfully identified at the scale of a pegmatite mine, if the database contains a sufficient number of samples to capture the chemical variability in the field. The precision of provenance studies also depends on the quality of geographic metadata associated with each sample.