

## Phosphorus sedimentation and release processes in a shallow hyper-eutrophic lake, Zeekoevlei in South Africa

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We investigate phosphorus (P) accumulation and release processes in a shallow alkaline hyper-eutrophic lake Zeekoevlei, in South Africa by analysing dissolved phosphate ( $\text{PO}_4^{3-}$ ) in waters and sediment pore waters, and organic P (OP), inorganic P (IP), calcium (Ca) and iron (Fe) bound P (HCl-P and NaOH-P respectively) fractions in sediments. Zeekoevlei is suspected for considerable internal P release from P-rich surface sediments that have accumulated from extensive cultural input by seasonally controlled catchment runoff. Absorption and coprecipitation by  $\text{CaCO}_3$ , planktonic P assimilation and aggregation of Ca-P with planktons control dissolved  $\text{PO}_4^{3-}$  removal from the water column and its subsequent sedimentation. Moreover,  $\text{PO}_4^{3-}$  absorption on iron (Fe) oxy-hydroxides contribute to the P absorption process in aerobic lake sediments. Low (10-12) atomic carbon/nitrogen (C/N) ratio indicates algae is the main source of sedimentary organic matter, and lake primary productivity, which is affected by dredging in 1983, controls the OP and influence the HCl-P and IP sedimentation. Significant refractory OP fraction in surface sediments indicate higher recycling of algal-bound P in water and restricts aerobic OP mineralization by benthic bacteria. Low (2-3) Fe/P ratio in surface sediments and high pore water  $\text{PO}_4^{3-}$  concentration (1.69-4.07 mg L<sup>-1</sup>) indicate higher P saturation and the fully utilised binding capacity of Fe for P. However, the high carbonate content (~6%) leads to continuous absorption of  $\text{PO}_4^{3-}$ , and results in high P retention in sediments. An upward decreasing concentration gradient of pore water  $\text{PO}_4^{3-}$  suggests insignificant diffusion-mediated upward transport of P, which is consistent with the above finding. These imply ineffectiveness of internal P release process from the calcareous oxic lake sediment towards the TP pool in Zeekoevlei.

## Kinetic and equilibrium iron isotopic fractionation at high temperature

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Because of a small relative mass difference between adjacent isotopes and because equilibrium fractionation decreases in magnitude with increasing temperature, detection of isotopic fractionation of Fe at high temperature has only recently been explored. Using MC-ICPMS,  $\delta^{56}\text{Fe}$  can now be analyzed accurately with precisions of better than 0.05 ‰ (e.g., Dauphas & Rouxel, 2006). Iron isotopic variations at high temperature have been documented in bulk rocks and individual minerals. In some instances, the mechanisms responsible for these variations can be identified.

*Subsolidus diffusion.* Mullen (1961) first showed that diffusion of Fe in metal could cause isotopic fractionation. During cooling of iron meteorites, growth of kamacite out of taenite is limited by diffusion. Several groups have measured Fe and Ni isotopic fractionation between taenite and kamacite in iron meteorites (e.g., Poitrasson *et al.*, 2005; Horn *et al.*, 2006). Modeling shows that this is best explained by differences in the diffusivities of the isotopes of Fe and Ni during diffusion at temperatures in the range ~450 to 650 °C.

*Evaporation and condensation.* The kinetic theory of gases predicts that there should be isotopic fractionation during evaporation or condensation, controlled by the degree of under or super saturation of the gas. Experiments of free evaporation of molten FeO and a complicated mixture of oxides show that Fe is indeed isotopically fractionated during these processes (e.g., Dauphas *et al.*, 2004). A zoned metal grain in a chondrite shows correlated zonings for Fe and Ni isotopic compositions (down to -6 ‰/amu at the core), demonstrating that it formed by condensation (Alexander & Hewins, 2004).

*Inter-mineral equilibrium fractionation.* Polyakov *et al.* (2007) showed that measurable equilibrium fractionation between mineral pairs such as pyrite-siderite or magnetite-siderite should exist at temperatures in excess of 500 °C. We measured the Fe isotopic fractionation between magnetite and siderite/pyroxene in BIFs metamorphosed to amphibolite and granulite facies. The measured compositions are in agreement with predictions, validating Fe isotopes as potential geothermometers in regionally metamorphosed terranes.

### References

- Alexander C.M.O'D. & Hewins R.H. (2004) *MAPS* **39**, A13.  
Dauphas N. & Rouxel O. (2006) *Mass Spectrom. Rev.* **25**, 515-550.  
Dauphas N. *et al.* (2004) *Anal. Chem.* **76**, 5855-5863.  
Horn I. *et al.* (2006) *GCA* **70**, 3677-3688.  
Mullen J.G. (1961), *Phys. Rev.* **121**, 1649-1658.  
Poitrasson F. *et al.* (2005) *EPSL* **234**, 151-164.  
Polyakov V.B. *et al.* (2007) *GCA*, submitted.