



Assessment of Phoslock[®] application in a tropical eutrophic reservoir: An integrated evaluation from laboratory to field experiments



Thais M. Yamada-Ferraz^{a,*}, Ana Paula E. Sueitt^a, Aline F. Oliveira^a,
Clarice M.R. Botta^b, Pedro S. Fadini^a, Marcos R.L. Nascimento^c, Bias M. Faria^d,
Antonio A. Mozeto^a

^a Laboratório de Biogeoquímica Ambiental/Núcleo de Estudos, Diagnósticos e Intervenções Ambientais, Universidade Federal de São Carlos, Caixa Postal 676, Rodovia Washington Luiz, km 235, 13565-905, São Carlos, SP, Brazil

^b Centro de Recursos Hídricos e Ecologia Aplicada, Universidade de São Paulo, Rodovia Domingos Innocentini, km 13, 13560-970, Itirapina, SP, Brazil

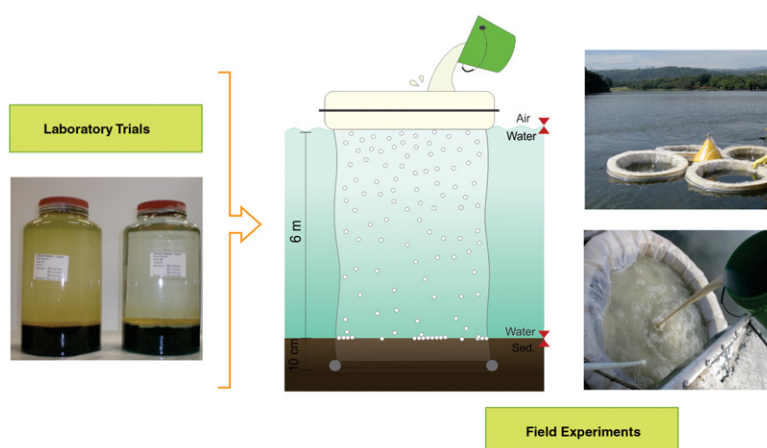
^c Laboratório de Poços de Caldas, Comissão Nacional de Energia Nuclear, Rodovia Poços de Caldas-Andradas, km 13, 37701-970, Poços de Caldas, MG, Brazil

^d Centro de Pesquisas Leopoldo Américo Miguez de Mello/Petrobras, Avenida Horácio Macedo, 950, 21941-915, Rio de Janeiro, RJ, Brazil

HIGHLIGHTS

- In microcosms Phoslock[®] application caused RSP reduction of 82% in the water column.
- In mesocosms Phoslock[®] application caused RSP reduction of 81% in the water column.
- Negative toxic impacts of Phoslock[®] addition to the water column were temporary.
- Changes in prevalent algae taxa were observed in the water column of mesocosms.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:

Received 18 November 2014

Received in revised form 4 July 2015

Accepted 8 July 2015

Available online 15 July 2015

ABSTRACT

The main objective of this study was to develop laboratory and *in situ* experiments to control reactive soluble phosphorus (RSP) concentration and to evaluate the possible changes and toxic effects caused by Phoslock[®] application in the Ibitaré reservoir (SE Brazil). Microcosm trials indicated that Phoslock[®] is a promising treatment because it shows fast response and effective RSP immobilization (reductions of 82% in the water column and

* Corresponding author. Tel.: +55 16 33518212; fax: +55 16 33518212.

E-mail address: thais_yamada@yahoo.com.br (T.M. Yamada-Ferraz).

Keywords:
Eutrophication
Remediation
Microcosm
Mesocosm
Ecotoxicity

69% in the sediment interstitial water). Acute toxicity test results suggested that the negative impacts of Phoslock® addition to the water column were temporary. *In situ* mesocosm trials did not suggest significant physicochemical alterations after Phoslock® application. Only turbidity was drastically altered by this treatment. Mean reductions in RSP concentration of 81% and 90% in the water column and sediment interstitial water, respectively, were observed 600 h after treatment. The mortality of *Ceriodaphnia silvestrii* and changes in prevalent algae taxa were observed in the water column. In the sediment, no acute toxic effect was observed, although the richness of benthic groups decreased due to the treatment. Overall, the results indicate that Phoslock® is a good option for the control of eutrophication in the studied reservoir.

© 2015 Elsevier B.V. All rights reserved.

1. Introduction

Aquatic environments all over the world are known to suffer from multiple stress factors (Burton et al., 2012) and cultural eutrophication remains the major water quality management problem for inland waters, including lakes and reservoirs (Klapper, 2003; Smith and Schindler, 2009).

The combination of high nutrient delivery from urban and agricultural sources and organic matter accumulation greatly exacerbate the symptoms of eutrophication (Robb et al., 2003). Phosphorus (P) loading has an important role in such process, and it is often associated with the proliferation of nuisance algal blooms, such as cyanobacteria. In addition, the release of nutrients, especially reactive soluble phosphorus (RSP) from the mobile sediment pool (so-called internal loading) may keep water bodies in an eutrophic state for years, even after the removal of external pollution sources (Søndergaard et al., 2007; Schindler et al., 2008). Therefore, remediation planning for the control of P point and non-point sources must be a priority (Jugnia et al., 2004).

The successful implementation of management actions aimed at reducing eutrophication and improving water quality and ecosystem integrity usually requires the adoption of an integrated approach: once the external nutrient sources are controlled, it is necessary to accelerate the restoration using *in situ* technologies (Klapper, 2003; Hickey and Gibbs, 2009). Several remediation techniques have been applied to reduce the internal RSP loading from sediments to overlying water (Klapper, 2003; Hickey and Gibbs, 2009; Rulkens, 2005) and one commonly employed treatment is sediment capping using materials capable of chemically precipitating P. Aluminum hydroxide (Cooke et al., 1993) and the mineral-based product Phoslock® (Douglas et al., 1999) are examples of such materials.

Phoslock® is a patented modified clay product originally developed by the Commonwealth Scientific and Industrial Research Organisation (Australia) to remove P from water bodies and stop algal bloom formation (Douglas et al., 1999; Robb et al., 2003; NICNAS, 2001; Afsar and Grooves, 2009). Phoslock® is produced by the reaction of bentonite and lanthanum chloride, during which most of the sodium ions in the clay are substituted by lanthanum (La) ions through electrostatic binding (NICNAS, 2001, 2014). The most outstanding property of the modified clay is its ability to remove RSP under anoxic conditions and over a wide range of pH values (Douglas et al., 1999; Robb et al., 2003; Ross et al., 2008). According to Akhurst et al. (2004) the application of sediment capping products, such as Phoslock®, may hold the key to reduce internal P loading and its associated problems in the short-term, providing time to establish long-term strategies to manage the polluted aquatic ecosystems.

Following the application of Phoslock® directly to the water column's surface, the La ions sorbed to the clay react with RSP to rapidly form a highly stable insoluble mineral. After settling on the sediment surface, the modified clay forms a thin adsorptive layer. Thus, as long as binding sites are still available, the product will continually bind new P from internal and external sources (Douglas et al., 1999; Robb et al., 2003; Ross et al., 2008; Afsar and Grooves, 2009).

Given the recognized role of RSP supply in the eutrophication process, the aim of this work was to assess the effectiveness of Phoslock® in controlling RSP internal loading in the Ibirité reservoir, a tropical urban eutrophic water body (SE Brazil). Phoslock® addition was proposed because it seemed to be a promising remediation technique to be applied in the reservoir due to its ability to promote efficient and quick RSP reduction. It is important to emphasize that the present study assumed that the local government will soon build a wastewater treatment plant to control the external nutrient inflows into the Ibirité reservoir.

Despite the substantial number of works related to Phoslock® application around the world, the present study has significant relevance because it combines chemical and biological data sets from laboratory to field evaluations, including ecotoxicological assays and phytoplanktonic and benthic community structure analyses. This strategy resulted in a more integrated and realistic assessment of the benefits and drawbacks of Phoslock® as a tool to control eutrophication.

2. Material and methods

Study site. The Ibirité reservoir is a tropical urban body of water situated in the metropolitan region of Belo Horizonte (Minas Gerais State, Southeastern Brazil—19°07'00"—20°02'30" S; 44°07'30"—44°05'00" W). The reservoir was built in 1968

Download English Version:

<https://daneshyari.com/en/article/4428234>

Download Persian Version:

<https://daneshyari.com/article/4428234>

[Daneshyari.com](https://daneshyari.com)