UMWELTFORSCHUNGSZENTRUM LEIPZIG-HALLE GMBH

CHLOROPHYLL MAXIMA – *explanation for resource management of the phytoplancton in acidic open pit mining lake*

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Introduction

Open pit mining lakes with pH values smaller than 4.3 represent extreme biotopes at a low trophic level. The primary production, important source for the production of organic carbon, seems to be limited by the very low content of inorganic carbon and soluble reactive phosphorus in the water column. Inorganic carbon is available only as CO_2 and the load is mainly controlled via balance rate between the water body and the atmosphere. The high iron and aluminium concentrations in the lake water and sediment support sedimentation and fixing of phosphorus at the lake bottom.

Previous investigations

Modern technology, e.g. an automatic profiling probe (Fig.1), is deployed in search for ecological niches where phytoplankton could develop and grow, in spite of extreme environmental conditions.
With this probe depth profiles of chlorophyll-a-fluorescence were measured in high local and temporal resolution in the open pit mining lake ML 111 (Lusatia, Germany) (Fig.2). It was possible to identify a stable chlorophyll-a maximum at a depth of 7m, as indicator of increased primary production. This site has a maximum depth of 10.5 m, which is significantly different from the mean depth of the lake (4.5 m). In the deepest part, differences were found in the chemistry and biology of water and sediment compared to other parts of the lake. Biogeochemical transformations (iron- and sulphate reduction) and the influence of groundwater were responsible for diffusive transport of inorganic and organic carbon and phosphorus from the pore water into the lake. In the past, algae was believed to peak at boundary layers due to higher availability of inorganic carbon.
A more detailed study has shown that the gradients of inorganic carbon, dissolved phosphorus and dissolved organic carbon cannot explain this phenomenon (Fig.3). Laboratory tests indicated that in the water from the maximum depth up to 2 m depth neither phosphorus nor carbon can be regarded as the limiting condition. In water from 7m depth 0.2 % of the surface radiation (PAR- measurement) were measured. Under these conditions, normally no positive photosynthesis balance can be calculated (compensation point for algae: 1% of the surface radiation; respiration = photosynthesis, no autotrophic growth) (Fig.3).
Nevertheless, algae of the genus *Chloromonas* could be identified within the chlorophyll maximum (Fig.4).

Prediction

In the range of wavelength for the relevant absorption peak of algae (680 nm), about 2 - 2.5 times more light can penetrate as shown by the integrated PAR-measurement (maximum transparency at 640 nm). The compensation point can be located in the red and acidic open pit mining lakes at greater depths compared with natural freshwater lakes. Light spectra of both lake types with the corresponding absorption spectra of single algae cells may yield information, whether in the open pit mining lakes a greater fraction of the photosynthetic active light is utilised (PAR: 400 – 700 nm).
Laboratory experiments support the hypothesis that traces of organic substances are responsible for the occurrence of the algae at 7 m water depth. In this case, it is presumed that these substances were limiting for growth.

Figure1 Automatic profiling probe (Idronaut Srl – Brugherio (MI) Italy); data acquisition and data transfer controlled by radio modem; parallel measurements of fluorescence, turbidity, pH, ORP, DO and el. conductivity against depth

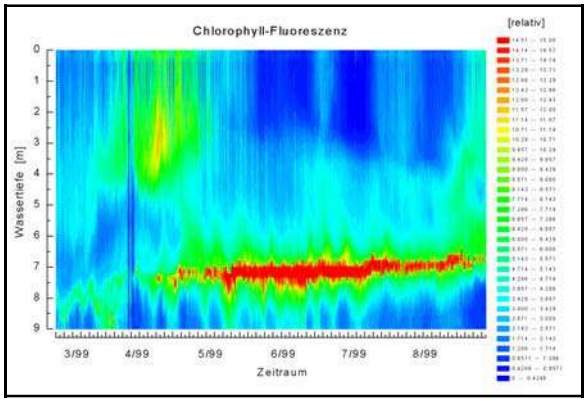

Figure 2 Temporal evolution (beginning of March until end of August 1999) of chlorophyll-a-fluorescence in the water column at the site of maximum depth of open pit mining lake ML 111.

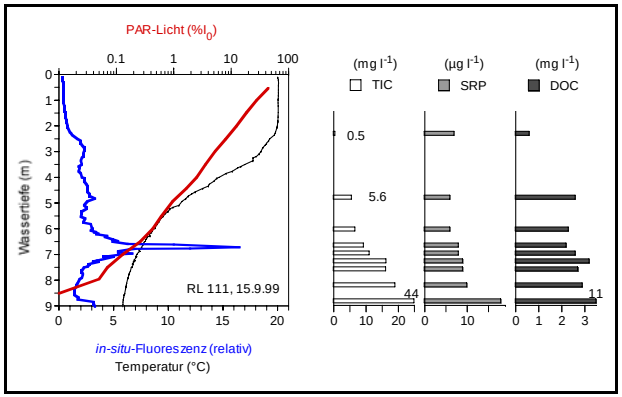

Figure 3 Depth-Profiles of various parameters taken on 15.6.1999 in the water column at the site of maximum depth of ML 111; left: surface radiation (PAR light), chlorophyll-a-fluorescence and temperature; right: TIC (total inorganic carbon), SRP (dissolved reactive phosphorus), DOC (dissolved organic carbon)

Figure 4 Algae in the zone of the chlorophyll-a maximum (genus: *Chloromonas*)