

# Behaviour of some trace elements at the oxic-anoxic interface in Lake Lugano (Switzerland, Italy)

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Main processes controlling trace metals distributions at the oxic-anoxic interface are oxidation-reduction of redox sensitive elements, precipitation-dissolution and complexation [1].

We have studied the behaviour of some dissolved elements in a permanent stratified lake (Lake Lugano, Switzerland-Italy). Our goal is to examine the influence of redox conditions on the concentration of dissolved metals and also on their partitioning between colloidal (10 kDa–0.45  $\mu\text{m}$ ) and ultrafiltered fractions (< 10 kDa).

## Location and sampling

Lake Lugano is located 60 km north of Milan (Italy). The northern basin of Lake Lugano, with a maximum depth of 288 m, is eutrophic and permanently stratified [2]. This meromictic lake is chemically rather than thermally stratified. Surface waters (above 80 m) are oxic while bottom waters (below 100 m) are totally anoxic.

Five campaigns were carried out to sample the water column at the oxycline level (60-130 m). Water samples were pumped using a peristaltic pump (Watson-Marlow, UK) and PVC tubing. The filtration system and the ultrafiltration cartridge were directly connected to the outlet of the tubing to avoid oxidation by air prior to separation processes. Waters were filtered through 0.45  $\mu\text{m}$  cellulose filters (Schleicher and Schuell, Germany). The ultrafiltration was done using a Tangential Flow cartridge with a nominal molecular weight cut-off of 10 kDaltons (Millipore, US). Waters samples were immediately acidified with ultrapure concentrated  $\text{HNO}_3$  (Merck, Germany) to prevent oxide precipitation.

## Methods

Trace elements concentrations (As, Co, Cu, Mn, Mo, Rb, Sc, Sr, V) were determined using a POEMS from Thermo Jarrel Ash. This ICP device combines both an optical emission spectrometer (OES) and a mass

spectrometer (MS), and allows the simultaneous determination of trace elements and major elements. We associated to this instrument an heated spray chamber desolvator, called Mistral (Applied Research Laboratory, Switzerland), which improves the sensitivity and reduces many interferences. This setting allows measurements at ppt levels. Laboratory works have been done in clean conditions. Iron was measured with a GFAAS (Perkin Elmer, US) and orthophosphate was determined colorimetrically using the molybdate blue method.

## Results and discussion

In vertical concentration profiles, four different behaviours of elements in filtrate (< 0.45 $\mu\text{m}$ ) are observed at the oxycline level in Lake Lugano:

- (1) Rubidium concentrations are constant with depth (cf Fig. 1a),
- (2) Arsenic presents a progressive increase through the oxic-anoxic interface (cf Fig. 1b),
- (3) Iron, Manganese and Cobalt concentrations increase rapidly at the oxycline (cf Fig. 1c),
- (4) Copper, Molybdenum present a constant decrease across the oxic-anoxic interface (cf Fig. 1d).

These profiles in the water column of Lake Lugano generally show similar tendency to those from other anoxic basins, in particular in Lake Hall [3].

Excepted Rb, dissolved elements are sensitive to the redox conditions.

Dissolved and ultrafiltered Rb concentrations do not change through the water column and the colloidal fraction seems to be negligible.

There are excellent correlations between dissolved concentrations of Mn and As and Co (around 0.9 and 0.98 respectively). In a less extent, these elements are also correlated with Fe (0.8 and 0.75). This relation can be explain by the release of adsorbed As and Co from Fe-Mn oxyhydroxides as this fraction is progressively dissolved across the oxycline and in anoxic waters [1, 3, 4]. The dissolution of Fe oxides happens around 15 meters deeper than dissolution of

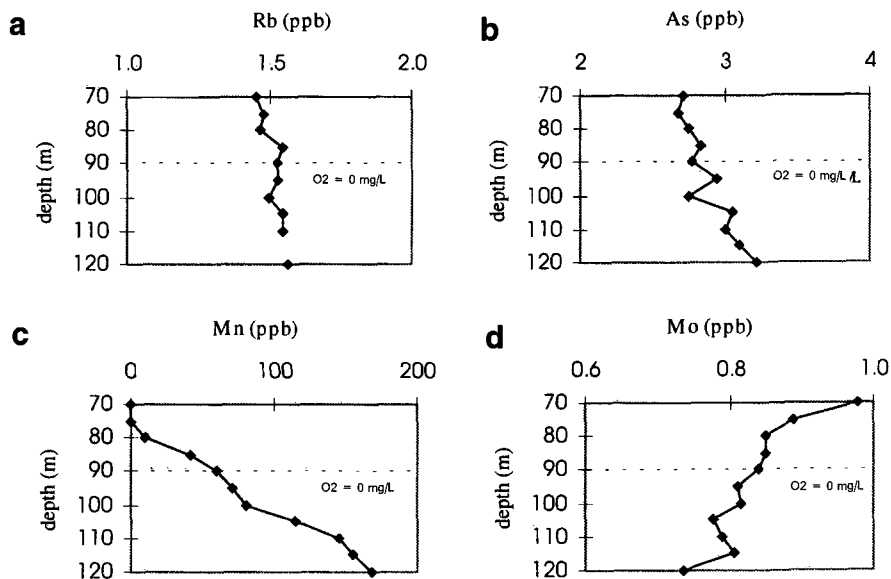


FIG. 1. Concentrations of some typical dissolved elements vs depth in Lake Lugano: (a) Rb; (b) As; (c) Mn; and (d) Mo.

Mn species, and also release of Co, which is consistent with the redox behaviour of these two elements.

The decrease of dissolved Cu concentration may probably be associated with an increase in the particulate fraction, as it is observed in another anoxic basins [1, 4]. These studies suggest that dissolved Cu is complexed with humic substances in oxic waters, reduces and forms sulphide complexes which progressively precipitate in the anoxic layer.

Mo seems to have a similar behaviour with a reduction of  $\text{Mo}^{\text{VI}}$  to  $\text{Mo}^{\text{IV}}$  and precipitation of colloidal sulphide species as shown by the increase of the colloidal fraction [3, 5].

## References

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