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Distribution of platinum and other traffic related metals in sediments and clams (*Corbicula* sp.)

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ABSTRACT

Platinum is part of traffic-emitted metals since the introduction of automotive catalyst converters. Still, automobile emissions are one of the major sources for metals in European river systems. However, field data on Pt is scarce and there is a lack of knowledge concerning the distribution and biological availability of Pt. Therefore, the distribution of traffic related metals (Cd, Cr, Cu, Ni, Pb, Pt, and Zn) was analyzed in sediment samples and in the Asian clam *Corbicula* sp. Samples were taken from three transects following road runoff inlets. Pt was introduced into the river by road runoff. The highest Pt concentrations in sediments were analyzed in the silt/clay fraction (45 ng/g), while the highest total Pt burden was obtained for the sand fraction, that makes up more than 60% of the sediment. Metal concentrations were related to the area of the drained street section as well as to their distance from the discharge point, and to grain size distribution within the sediment. Pt and other traffic related metals were accumulated by clams. Due to the feeding behavior of the freshwater mussel *Corbicula* sp. Pt concentrations in the soft tissue remain relatively low (max Pt concentration: 1.3 ng/g freeze dried soft tissue) and acute lethal or toxic effects therefore appear to be unlikely. Nonetheless, chronic exposure effects still have to be examined.

1. Introduction

Following the introduction of automobile catalytic converters in the 1980s the distribution of platinum group elements (PGE) and especially of Pt is monitored in different environmental matrices as can be seen in several reviews (Dubiella-Jackowska et al., 2009; Ek et al., 2004; Haus et al., 2009; Hoppstock and Sures, 2004; Rauch and Morrison, 2008; Ravindra et al., 2004; Ruchter et al., 2015; Zereini and Alt, 2000; Zimmermann and Sures, 2004). To a large extend, studies on Pt in the environment are focused on the influence of traffic related Pt on terrestrial habitats. Accordingly, there is an extensive amount of research on matrices like air, road dust, particulate matter (e.g. PM-10), soil and plants along highways, whereas only few studies concentrate on the distribution of Pt in aquatic ecosystems (reviewed by Haus et al., 2009). To the best of our knowledge, no study investigated the fate of Pt directly at the inlet site of rivers so far. Therefore, the aim of the current study is to identify sediment fractions, which contain elevated levels of Pt, to understand how Pt is transported in a small river, and to compare the discharge of Pt with that of other metals.

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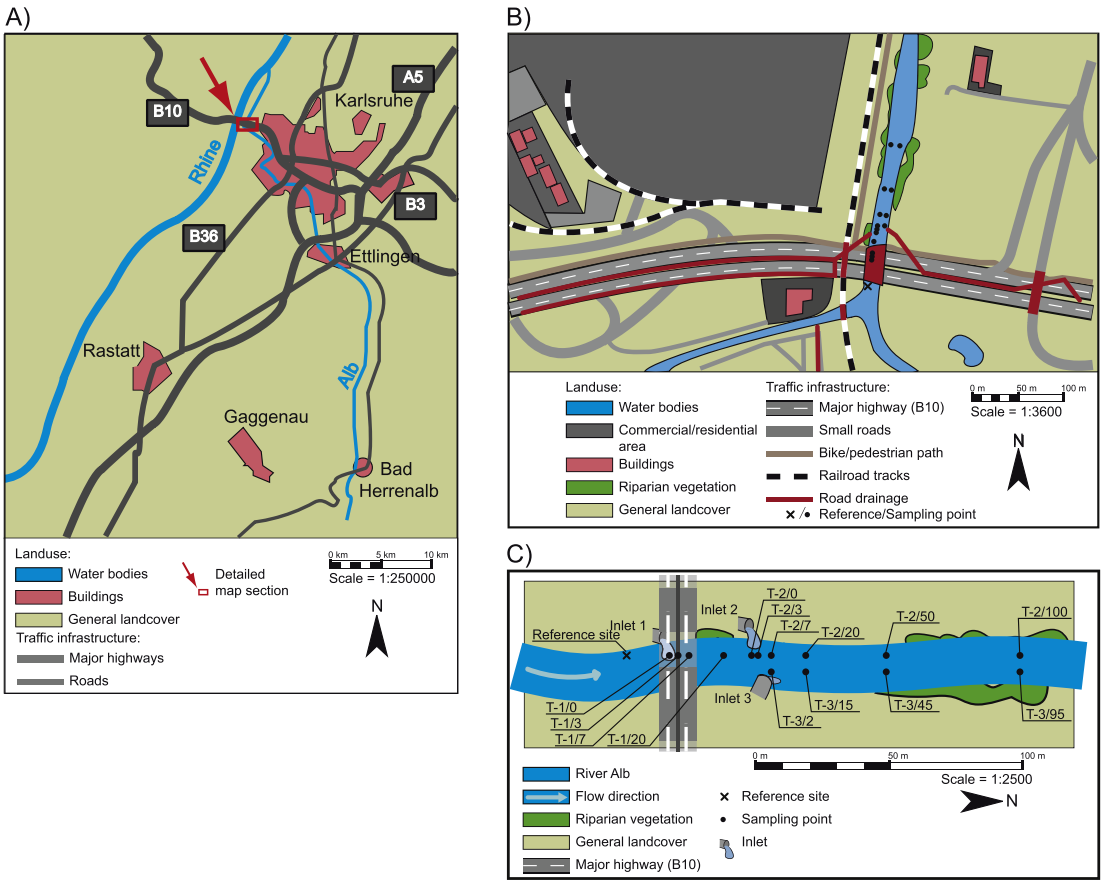

Fig. 1 – Overview of the sampling site. A) The river Alb from the source in Bad Herrenalb to the opening into the river Rhine. The width of the river Alb is not true to scale in order to make it visible. B) The drainage system of the B10 at the sampling site of the river Alb. C) The location of the reference site and all sampling points in the river Alb in detail.

Next to the question of the Pt distribution in sediments, its bioavailability under natural conditions largely remains unknown. Even though Pt is a precious metal, it has been shown to be biologically available to different aquatic organisms like plants (Farago and Parsons, 1994; Hees et al., 1998), gammarids (Haus et al., 2007), asselids (Haus et al., 2007; Moldovan et al., 2001; Rauch and Morrison, 1999), mussels (Frank et al., 2008; Sures and Zimmermann, 2007; Zimmermann et al., 2005a, 2002), snails (Osterauer et al., 2009), and different fish species (Essumang et al., 2008; Hees et al., 1998; Osterauer et al., 2009; Sures et al., 2003; Zimmermann and Sures, 2004; Zimmermann et al., 2005b). Most of these studies reported the uptake of Pt by organisms under controlled laboratory conditions following exposure to soluble Pt salts at comparatively high concentrations. Uptake of Pt in the field, however, was only shown for asselids, gammarids and fish (Essumang et al., 2008; Haus et al., 2007; Moldovan et al., 2001; Rauch and Morrison, 1999; Sures et al., 2005) sampled either at highly contaminated sites (Moldovan et al., 2001; Rauch and Morrison, 1999) or at random places (Essumang et al., 2008; Haus et al., 2007; Sures et al., 2005). So far none of these studies followed a systematic approach in the sense that Pt concentrations were monitored in sediments and biota along a transect.

Accordingly, sediment and biota samples were taken in a small river, which intersects a major road near Karlsruhe, Germany. To analyze the metal distribution in different sediment grain sizes as well as in the Asian clam *Corbicula* sp., samples were taken along three different transects starting at three different inlets of road runoff. Samples were analyzed to investigate the distance range at which traffic related metals including Pt can be distributed within a small river. Further, correlation analysis for Pt and other traffic related metals in sediments were conducted. Finally, the bioavailability of all analyzed metals was studied in the invasive bivalve *Corbicula* sp. in order to detect the extent to which Pt and other traffic related metals are accumulated by clams. In total, the obtained data should provide a reliable basis for an estimation of the ecotoxicological risk of Pt to bivalves.

2. Material and methods

2.1. *The sampling site*

The river Alb close to the city of Karlsruhe was chosen as sampling site to analyze the distribution and occurrence of Pt in an aquatic system. The river Alb originates near Bad Herrenalb, located in the German state of Baden-Württemberg and flows 52 km until it empties into the river Rhine near Karlsruhe. The Alb has a watershed of 457 km (Regierungspräsidium Karlsruhe, 2009). The sampling site for