

Water Rock Interaction [WRI 14]

Natural attenuation of heavy metals (Cd, Cr, and Pb) in a water table aquifer underlying an industrial site

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Abstract

We investigated 3 heavy metals in a contaminated shallow aquifer, in which the pH ranges from 1 to 10. We show that natural attenuation takes place through various geochemical processes (coprecipitation and precipitation), as acidic pH is buffered by carbonate minerals.

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1. Introduction

Contrarily to many organic pollutants, metallic elements are persistent in the environment since they do not degrade. Some natural attenuation can however be provided by geochemical mechanisms which remove metallic elements from the aqueous phase, *i.e.* precipitation and adsorption.

2. The industrial site and its fill aquifer

We report here an investigation of an industrial site located within the city of Bordeaux (south-western France). The activity involved the manufacture of two products. Sulfuric acid was synthesized using pyritic minerals as sulfur source during the first half of the last century. Copper sulfate crystals have been and were until recently the main product. They were obtained by the attack of recycled copper with

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sulfuric acid. The crystals are used as a fungicide in agriculture, under the generic name of "bouillie bordelaise".

The industrial site is located on a phreatic fill aquifer (*ca.* 5 m thick) overlying an aquitard. Piezometers were drilled. Five sampling campaigns included on site measurements (pH, dissolved O₂, redox potentiel, conductivity and temperature) and water sampling. Heavy metals (Cd, Cr, and Pb) were analyzed by Zeeman flameless atomic absorption spectrophotometry after proper on site treatment (filtration at 0.2 µm, acidification with suprapure nitric acid). Sulfate was determined by ion chromatography on filtered samples.

3. Hydrogeochemistry of the aquifer

Two zones were identified in the aquifer (Figure 1). In the Northern part of the site, the groundwater pH is very low (down to 1), heavy metal and sulphate concentrations are high (up to 2.0 mg/L for Pb, 1.7 mg/l for Cr, 100 µg/L for Cd and 44 g/L for sulphate). In the rest of the site the pH is neutral, sulphate concentrations are moderately high (around 1 g/L), and heavy metal concentrations are low (see below). As groundwater flows away from the polluted zone (piezometric mound) towards the periphery of the site (Figure 1), the pH increases from 1 to 7, while the heavy metal dissolved concentrations decrease by 4 orders of magnitude for chromium, (from 1.7 mg/L to 0.5 µg/), 3 orders of magnitude for cadmium (from 100 to 0.1 µg/L) and lead (2 000 to 2 µg/L) and only about 50 fold for sulphate (44 g/l to around 1 g/l). Data for chromium shown in Figure 2 are representative of a general trend for the 3 heavy metals, i.e., high dissolved concentrations at low pH and a strong decrease as pH increases from 4 or 5 to 6 or 7 (depending on the metal).

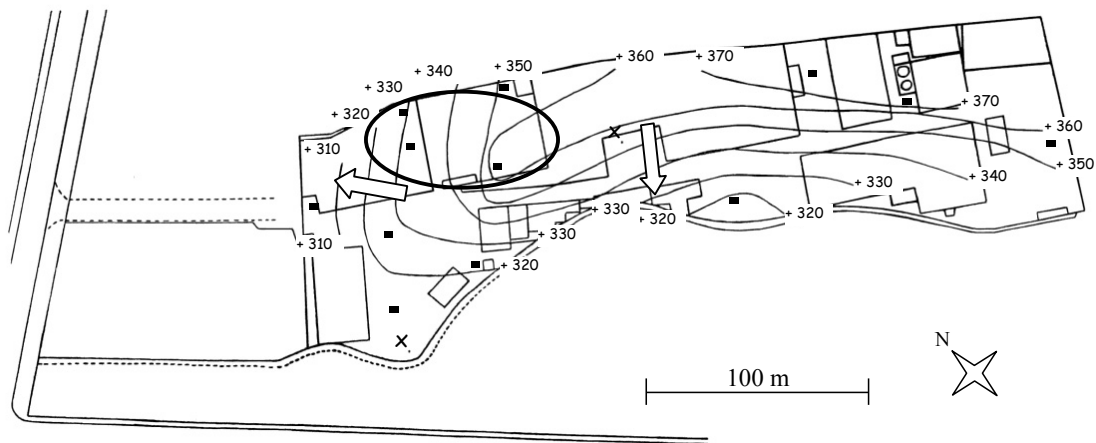


Fig. 1. Piezometric map and location of the heavily polluted zone (circled area). The 2 arrows show the trends in groundwater flow, towards the nearby Garonne River and towards a drainage ditch.

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