Speciation and micro-scale spatial distribution of As in a mining-affected river floodplain

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Many rivers worldwide are polluted with trace elements originating from past or present mining. Even after closure and remediation of the mines, highly contaminated floodplains often remain as a source of contaminant release into river and ground water. Arsenic (As) has a high potential for mobilization unter reducing conditions, e.g. during soil flooding, but this strongly depends on the speciation of As among other factors.

We studied the speciation and micro-scale distribution of As in alluvial soils and sediments along the river Ogosta in NW-Bulgaria. Ogosta, an important tributary to the lower Danube river, was strongly affected by mining of Au, Fe, and Pb/Ag between 1951 and 1999.

Soil samples were collected along transects ranging from the river bed through the lower and upper floodplains, taking special precautions to minimize oxidation. All samples were analyzed for soil pH, mineralogy, elemental composition, and oxalate-extractable As and Fe. Arsenic speciation was investigated by As K-edge X-ray absorption spectroscopy (XAS). Thin sections of undisturbed soil were prepared and examined by micro-X-ray fluorescence (μ-XRF) spectrometry and μ-XAS. Additionally, selected soils were size-fractionated to explore the elemental composition, mineralogy, and As speciation as a function of particle size.

Soil As concentrations in the floodplain ranged between 40 and 37, 400 mg kg^{-1}. Highly As-contaminated soils were also enriched in Fe, Mn, S, Pb, Sb, and other trace elements. Bulk and micro-XAS, combined with oxalate-extractions, revealed that most As was present as As (V) sorbed to poorly-crystalline Fe (III)-oxyhydroxides, with smaller amounts of As bound in arsenopyrite. The fine particle size fractions <5 and 5-20 μm were strongly enriched in As (up to 93, 000 mg kg^{-1}) as compared to the corresponding bulk soils. These size separates contained only traces of arsenopyrite and exhibited very high oxalate-extractable As and Fe contents, reaching molar Fe/As ratios of <5. Our results suggest that As and Fe in these soils should be readily bioavailable for microbial reduction upon soil flooding.

Groundwater Recharge in the Santo Tomás Valley, Baja California, México

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Overview

The purpose of this study is to better understand Mountain Front Rrecharge (MFR) and Mountain Block Recharge (MBR) in a mountainous watershed in Baja California by creating a detailed fracture-trace map of the Santo Tomas basin along with stable isotope (O, H) and chemical analyses of spring water (thermal and cold), groundwater, and stream runoff throughout the study area.

This study focused on the topography, geology, vegetation and hydrologic characteristics of the eastern section of the Santo Tomas valley, located approximately 50 km southeast of Ensenada. Each method used in study was completed with the intention to integrate all data to better understand MBR in the study area.

Methods

Models of elevation, slope, lithology, vegetation, and fractures within the 300 km^2 watershed were created to help characterize the basin. Images were generated in ArcMap, using DEM data, field observations, and LandSat satellite imagery. Each visual was examined individually as well as in conjunction with other physical and chemical parameters to better understand the dynamic of the watershed.

Results

The stable isotope (δ^{18}O and δ^2H) data show two distinct types of spring water within the watershed representing local and regional flow paths. Thermal springs, display a -1.9‰ δ^{18}O depletion compared to the other spring water, indicativing a higher elevations recharge or older waters. This distinct isotopic signal was found 15 km downstream in the alluvial aquifer, showing that a significant amount of water is recharging the basin aquifer via the mountain block along this flow regime. The thermal system and most cold-water springs surface along active faults, which appear to transmit more water than the undifferentiated fractures. An isotopic distinction can be seen between the hot and cold springs within the watershed despite that all the spring samples are taken between 400 - 550 m elevation.