Speciation and distribution of arsenic in water at Bakyrchik gold mine, Kazakhstan

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Arsenic contamination of groundwater is of widespread global concern, with hazardous societal impacts as well as impacts on ecologies and natural capital. The association of arsenic with mining operations worldwide is a further concern that has received relatively little public attention. Gold mining operations in Bakyrchik (Kazakhstan), based on extraction from arsenic bearing sulfide minerals, lead to the formation of arsenic-bearing waste. The high As content of the residuum poses potential environmental problems associated with waste disposal and acceleration of the natural processes of As mobilization. Speciation of As in water is a crucial step in understanding its biogeochemical behaviour and fate in mining influenced environment. This study is the first attempt to investigate speciation of As in the water bodies in the vicinity of the Bakyrchik gold mine.

We collected water samples from local creeks, mine shaft and pit lake during a field campaign in summer 2013. Arsenic speciation analyses were carried using a HPLC-ICP-MS system. Determination of the total dissolved As and other elements were conducted on a PerkinElmer SCIEX Elan DRC II quadrupole ICP-MS. A Thermo-Dionex ICS3000 Ion Chromatography system was employed for the determination of anions.

Five As species were determined in local water bodies: As(III), AsB, DMA, MMA and As(V) with the predominance of the latter. A significant amount of As (III) was found in some surface water samples ranging from 14.03% to 28.55%. An observed As species distribution can be drawn as: As(V) > As(III) > AsB > DMA > MMA. A variability in As species concentration across the narrow pH and Eh range demonstrates that neither pH nor Eh determine speciation of dissolved As and the role of biochemical processes is significant in the study area. PHREEQC geochemical code has been used to determine the saturation indices of the waters with respect to relevant minerals. The data obtained will be used to construct a geochemical model of As in the solid-water system of the Bakyrchik area, identifying the key chemical reactions controlling the mobility of As at the Bakyrchik deposit. Ultimately this will provide a scientific basis for any future remediation programme of this type of ore deposit, applicable both nationally and globally.