

NATURAL ATTENUATION OF ARSENATE-CONTAMINATED RIVER IMPACTED BY ACID MINE DRAINAGES: CHARACTERIZATION OF SUSPENDED PARTICULATE MATTERS

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Introduction

Arsenic is commonly present in sulfide bearing ore bodies in addition of weathered volcanic and marine sedimentary rocks, and fossil fuels. When the worthy heavy metals, such as gold, copper, zinc, are processed, tailing and waste rock, which contain reduced arsenical sulfides such as arsenopyrite, orpiment and realgar, are liberated. Anthropogenic activity, including drainage from mining and tailing wastes, contributes to the arsenic pollution in aquatic and terrestrial environments. It is well-known that arsenic is removed by co-precipitation with iron (Daus and Wennrich, 1998).

There are two rivers impacted by the same arsenic contaminated source of acid mine drainage in southern part of Hokkaido. It was observed that in both rivers the concentrations of arsenic decreased along the streams, however, they have some contrast features: that is, one is more turbid with the slower rate of reduction of arsenic concentration, another one is clearer with the faster rate of reduction of arsenic concentration. It is not clear whether suspended particulate matters (SPM) is the source to desorb heavy metals or plays an important role to remediate (Acterberg et al., 2003). In the present work, the process of natural attenuation with each other was compared and the role of suspended particulate matters in the river in removal of arsenic was examined.

Site description

The present study site is Amemasu and Shojin basin, which is located in 2-6 km east of Ohnuma Lake in the southern Hokkaido, Japan. Amemasu river has a portal of Chugiriko from Old Shojingawa-mine drainage between A-8 and A-9, and Shojin river has a portal of Ichiuko and Sanko from the same mine drainage between S-6 and S-7. Shojingawa mine, which had production of sulfur in those days, has been abandoned several decade years ago. Water chemistry at several points in two rivers was characterized by HG-AAS for As, ICP-OES for other heavy metals and ion chromatography for major cations and anions (**Table 1**) as well as pH and Eh vs NHE to provide for geochemical calculation by MINTEQA2. The results revealed that both water chemistry was saturated for hematite, goethite and lepidocrocite though the whole streams. Though both are impacted by acid mine drainages containing arsenic, natural remediation was observed in Shojin river more effectively than in Amemasu river. Two rivers are merged into the junction after A-1 and S-1 in **Fig. 1**. The arsenic concentration at A-1 is 3 ppm, which is beyond the maximum contaminated limit (MCL), a diluted by mixing with Shojin river to be less than MCL of arsenic at the junction of two rivers. Although the turbidity of upstream was higher in Amemasu river, suspended particulate matters (SPM) decreased with along both of the streams. It is important to elucidate mechanism of decay of natural attenuation of arsenic in Amemasu river.

Characterization of suspended particulate matters (SPM)

SPM was collected from A-1 in Amemasu river, where the highest SPM was observed, and sieved in several fractions using sieving mesh filters. Each fraction was provided for 8 steps of sequential extraction (Keon et al., 2001) and XRF analysis. The finest fraction (0.65-50 μm) of SPM included the highest concentrations of As, Fe and Zn, while Al concentrations were similar among all particle size fractions and Si concentrations were higher in larger particle size fractions. According to the sequential extraction of SPM, As species were distributed in the order of silicate bounded, ion-exchangeable, and iron bounded type. Based on the chemical stability, poorly crystalline Fe minerals were the most important form to immobilize arsenate.

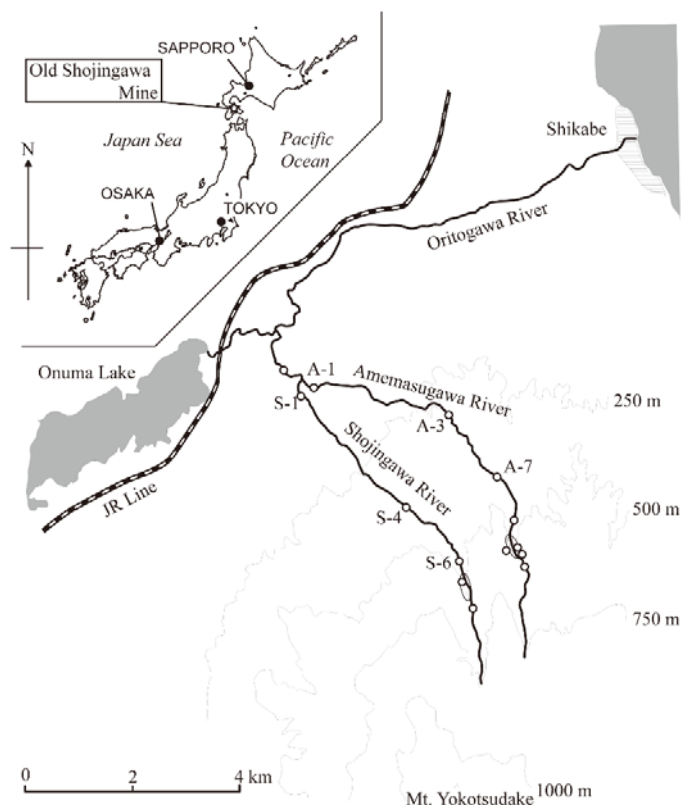


Fig. 1 Study area around Shojingawa mines in Hokkaido.

Table 1 Water chemistry and SPM in Amemasu and Shojin rivers

	A-1	A-3	A-7	A-8	A-9	S-1	S-4	S-6	S-7
Temp/°C	8.9	9.1	10.3	8.3	8.7	10.7	10.2	9.3	7.3
pH	3.49	3.10	3.04	2.92	2.70	3.35	3.06	3.10	2.60
Eh/ mV	709	755	756	799	701	712	765	743	731
As ³⁺ / ppm	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
As ⁵⁺ / ppm	3.45	6.58	15.85	16.00	22.90	0.006	0.027	0.063	0.715
Ca ²⁺ / ppm	9.17	9.59	10.75	18.16	15.47	11.56	9.29	5.86	6.59
Fe ²⁺ / ppm	3.833	1.021	1.366	14.612	29.904	1.538	2.793	5.217	7.942
Fe ³⁺ / ppm	n.d.	5.554	14.484	1.388	n.d.	2.137	4.407	3.533	0.408
K ⁺ / ppm	1.39	1.34	1.38	1.36	2.21	1.29	1.24	1.3	2.07
Mg ²⁺ / ppm	2.24	1.91	1.96	2	2.41	3.09	2.49	1.76	2.66
Na ⁺ / ppm	6.51	6.13	5.83	5.93	6.99	6.5	5.6	5.13	6.01
SO ₄ ²⁻ / ppm	77.15	18.65	138.55	174.95	236.2	88.05	133.3	113.85	268.45
Cl ⁻ / ppm	6.3	1.06	5.1	5.4	6.1	0.5	4.45	4.2	4.75
SPM/ g m ⁻³	4.7	2.4	3.3	0.2	n.d.	1.8	1.9	n.d.	n.d.

n.d. not detected.

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