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Investigation of Abandoned Metal Mine Effect on Watershed

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Abstract. Primary and precise investigations on soils of abandoned mine areas have been performed, but investigation on drain water effect on the nearby watershed has not been performed. 6 mines were selected for the investigation of drain water effect on watershed. 193 and 165 samples of water and soil(mainly sediment) have been collected from abandoned mine areas, respectively. Concentrations of 10 metals in water and soil samples were analyzed after pretreatment of each sample using ICP-MS and ICP-OES, respectively. 18 water samples have been imported eatable water pollution standard. 41 soil samples have been imported basis of concern & action criterion. Primary pollutants were arsenic at Yeongdae, and zinc at Daeduk and Suncheonyuil. Highest ferric concentration was measured at Bub-hwajae in Cheong-dalkeum. High aluminium and ferric concentration were measured at Gundong stream in Kangjin and Myoungbong bridge in Myoungbong. Concentrations of heavy metal in soils decreased as the distance from pollution source increased. Accumulation of metal components in a dam or reservoir was observed and a dam or reservoir tended to prevent the spread of pollutants, preventing the flow of sediment or mine ash.

Keywords: heavy metal, abandoned mine, watershed, mine drainage,

1. Introduction

The AMD(acid mine drainage) is generated by the oxidation of sulfide-bearing minerals exposed to weathering conditions. It is characterized by acidic pH, a high level of dissolved metals (e.g., As, Cd, Cu, Zn) and anions (e.g., sulphates and carbonates)(Razo, Carrizales et al. 2004). Primary and precise investigations on soils of abandoned mine areas have been mainly carried out until now, but investigation on how drain waters of the abandoned mine areas influence the nearby watershed has not been performed yet. In this study, abandoned mine and its drainage effect on nearby watershed was investigated. 6 abandoned metal mines were selected and a lot of water and soil samples were collected from the mines.

2. Methods

Soils(mainly sediments) have been sampled at mine head, 50m, 100m, 200m, 500m, 1km, 2km from the mine head. Water samples have been collected at the same position of the soil samples. Water flow rate in the sampled stream was measured using flow meter. Sampled water was filtered before concentration measurement using ICP-MS. Soil samples were pre-treated using aqua regia (nitrohydrochloric acid) following Korea methods(ES 07301, ES 07400) before concentration measurement using ICP-OES. pH, Cd, Cu, BP, Zn, Ni, Cr, As, and Hg have been analyzed from all samples.

3. Result and discussion

193 samples of water have been sampled from surface and ground water and analyzed. 18 samples of water have been imported eatable water pollution standard. 165 samples of soil have been sampled from river bed and analyzed. 41 samples of soil have been imported basis of concern & action criterion. Table 1 shows the summarized result for each abandoned mine.

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Table 1. Summarized result for each abandoned mine

Mines	No of soil samples	Basis of Concern & Action criterion over	No of water samples	Eatable water standard over
Yeongdae	29	14 unit imported (Copper1, Zinc10, Arsenic 10, Cadmium 8, Lead 6)	28	8 unit imported (Arsenic 8)
Daeduk	28	8 unit imported (Copper 2, Zinc 3, Cadmium3, Lead 8)	28	4 unit imported (Lead 2, Zinc 1, Cadmium 1)
Myoungbong	28	9 unit imported (Nickle 1, Zinc 1, Cadmium 1, Arsenic 8)	37	0 unit imported
Cheong-dalkeum	25	5 unit imported (Nickel 2, Zinc 2, Arsenic5, Cadmium2)	22	3 unit imported (Arsenic 3)
Suncheonyouil	30	4 unit imported (Copper 3, Zinc 2, Cadmium 3, Lead 3)	36	3 unit imported (Aluminium 2, Copper 2, Zinc 4, Cadmium2, Lead 1)
Kangjin	25	1 unit imported (Arsenic 1)	42	3 unit imported (Zinc 3)

In Yeongdae mine, high arsenic concentration was measured in mine drainage but arsenic concentration in river water was lower than eatable water standard. It is well known that dissolved As species are stable over a broad pH range from 1 to 12, which confirms that pH is not a determinant parameter for As mobility(Smedley and Kinniburgh 2002). It is speculated that dissolution arsenic (III) is oxidized to arsenic (V) by oxygen in the atmosphere or iron and manganese in water solution, and oxygenated arsenic (V) is precipitated, reducing the concentration in surface water.

Main pollutions of Daeduk mine were cadmium, zinc and lead in soil and water. There was no mine drainage so direct effect was not expected. Nickel, zinc, and arsenic were main pollutions in Myoungbong mine. There was small mine drainage. Arsenic was primary pollution in soil and water of Cheong-dalkeum mine. Main pollutions of Suncheonyouil mine were zinc, cadmium, lead, and copper in soil and water. Main pollutions of Kangjin mine were appeared zinc and arsenic in soil and water.

Concentrations of heavy metals in soil and sediments were reduced by distance from the source of pollution significantly.

Fig 1 shows seasonal metal load due to Yeongdae drainage. Seasonal fluctuation was small, even though the load was highest in summer. Total metal load was 3.23 kg/day in summer. Metal compositions of Yeongdae drainage were As 1.47, Al 0.59, Fe 0.78, and Zn 0.35 kg/day(Fig 2).

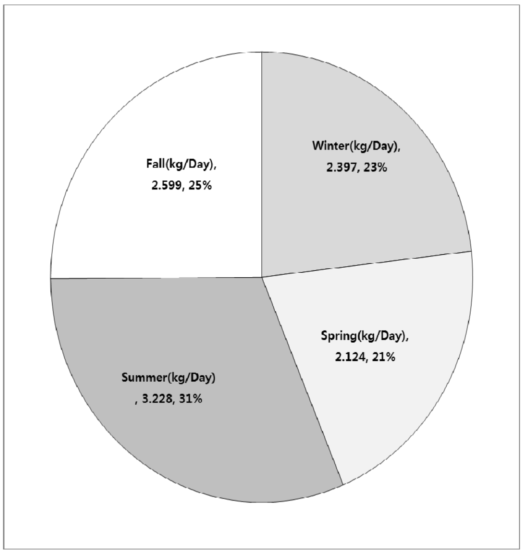

Fig 1. Flow out metal load in Yeongdae by season (kg/day)

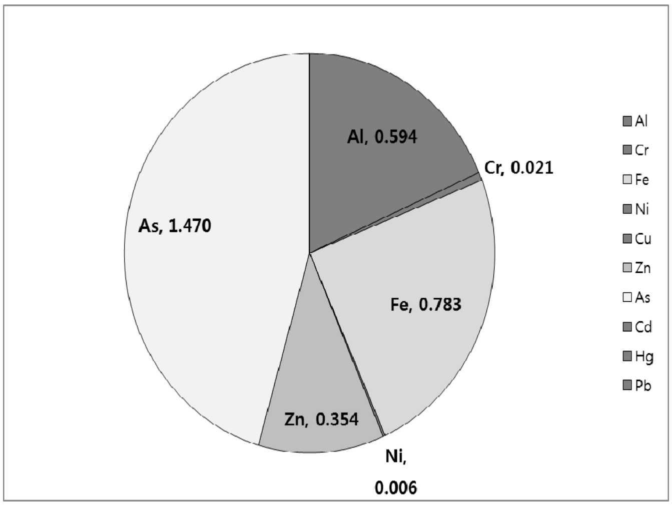

Fig 2. Metal ratio of components in Yeongdae drainage (kg/day)

4. Acknowledgements

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5. References

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