Assessing the cost and applicability of passive treatment and risk-based point-of-use management for 26 legacy mine drainages

Kohei Doyama[1], Yuichi Iwasaki[2], Takaya Hamai[3], Tetsuo Yasutaka[1], Shingo Tomiyama[4]

[1]*Institute for Geo-Resources and Environment, Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST), Central 7, 1-1-1, Higashi, Tsukuba, Ibaraki, 305-8567, Japan, doyama.kohei@aist.go.jp, t.yasutaka@aist.go.jp*

[2]*Research Institute of Science for Safety and Sustainability, National Institute of Advanced Industrial Science and Technology (AIST), 16-1 Onogawa, Tsukuba, Ibaraki 305-8569, Japan, yuichi-iwasaki@aist.go.jp*

[3]*Japan Oil, Gas and Metals National Corporation (JOGMEC), 2-10-1 Toranomon, Minato-ku, Tokyo 105-0001, Japan, hamai-takaya@jogmec.go.jp*

[4]*Division of Sustainable Resources Engineering, Faculty of Engineering, Hokkaido University, Kita 13, Nishi 8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan, tomiyama@mmc.co.jp*

Extended Abstract

In Japan, more than 70 legacy mines are involved in mine drainage treatment, of which 24 mines (26 mine drainages) are under the jurisdiction of local authorities because of the absence of responsible parties (Koide et al. 2012). Since the subsidy system was set up in 1974, the 26 legacy mine drainages have consumed approximately 2 billion JPY (≈ 13.4 million USD) annually for 50 years. In these legacy mines, sustainable mine drainage management is important for environmental protection as well as economic efficiency. In response to this situation, in Japan, two measures are promoted nationally: (i) passive treatment (PT), a cost- and labour-saving treatment process, utilizing naturally occurring biological and physiochemical reactions, and (ii) point-of-use management, a method that ensures water quality is maintained in rivers receiving mine discharges by establishing site-specific water quality benchmarks. This study evaluated the applicability of these measures to 26 legacy mine drainage systems and ranked them based on their applicability in strategically promoting the optimization of mine drainage management. Finally, we calculated the cost saving effect under the scenario that both measures are appropriately implemented.

The applicability of PT was evaluated using a 5-year dataset of mine water chemistry (dissolved Cd, Pb, As, Cu, Zn, Mn, and total Fe concentrations and pH) and flow rate. Comparing the water chemistry and flow rate with the PT processing capacity, the applicability was categorized. Point-of-use management applicability was evaluated using a simple dilution method by estimating the metal concentrations downstream where untreated mine drainage was discharged. The potential cost reductions resulting from these measures were then estimated based on the cost data which were obtained from full-scale and pilot scale field testing and the actual annual expenses for mine drainage management (METI 2018).

Our results showed that PT could be applied to 14 mine drainages with low dissolved Cd, Cu, Zn, and Pb concentrations (<10 mg/L) and flow rate (<0.5 m3/min), whereas it was not suitable for 10 mine drainages due to extreme total Fe concentrations (59.0–893.8 mg/L). Point-of-use management could be applied to 10 mine drainages because their estimated metal concentrations complied with downstream water quality standards, even without treatment. Either PT or point-of-use management can be applied to 23 mine drainages, potentially reducing 4.4 million/year USD (33.4% of total costs) (Fig. 1). However, both measures could not be applicable to the remaining three mine drainages, containing excessive total Fe (158.4–893.8 mg/L), consuming

8.0 million/a USD for their treatment (58% of the total costs). Our findings suggest that promoting both measures is effective in achieving sustainable mine drainage management. Nonetheless, regarding cost reduction, multiple approaches may be necessary to optimize the management of the remaining three mines.

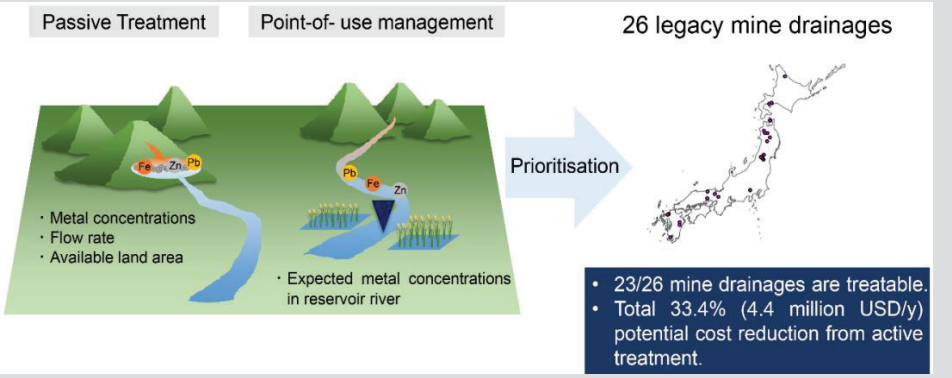

Figure 1 *Application framework of passive treatment and point-of-use management against 26 legacy mines in Japan*

References

Koide, R., Tokoro, C., Murakami, S., Adachi, T., Takahashi, A. (2012) A model for prediction of neutralizer usage and sludge generation in the treatment of acid mine drainage from abandoned mines: case studies in Japan. Mine Water Environ. 31, 287–296. https://doi.org/10.1007/s10230-012-0200-x.

METI, 2018. Fiscal year 2018 grant decision status of subsidies, etc. (April 2018 to September 2018). METI Tohoku Bureau of Economy, Trade and Industry (in Japanese). https://www.tohoku.meti.go.jp/koho/koshin/kobo/kofu_kettei.html.