Influence of acid mine drainage on river water quality in the vicinity of the Osamu Utsumi uranium mine, Caldas-Minas Gerais, Brazil

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Abstract

Mining and milling industries have a strong potential to cause environmental impacts, especially when the waste rock and tailings contain oxidizing sulfides. This creates one of the most perverse forms of environmental contamination: Acid Mine Drainage (AMD). The timescale for the generation and pollution caused by the AMD may reach hundreds of years. Hence, the operator should ensure that the control measures adopted will be effective for a long time after mine closure. The uranium mining and milling facilities of Caldas, currently named UTM/Caldas, are undergoing decommissioning. The main environmental problem in the UTM/Caldas is the AMD, present in the tailings pond, open pit (Osamu Utsumi Mine) and waste rock piles. Preliminary results are presented on the quality of river waters in basins in the vicinity of UTM/Caldas, focused on Eh and pH parameters. Three watersheds were investigated – Taquari River, Consulta and Soberbo Creeks. Twelve sampling stations were installed in order to carry out the investigation. Ten stations were located at nearby water streams and the remaining two stations at effluent barriers: at the Nestor Figueiredo Pond (NFP), located in the Consulta watershed, and at the settling pond 2 (D2) in the Soberbo watershed. NFP receives effluents from waste rock pile 4 (WRP4), whereas D2 collects effluents from the tailings pond. *In situ* measurements were performed in all sampling stations across the dry and rainy seasons of 2010 and 2011, using a handheld water quality meter (Ultrameter II6P).

Results show that: i) waters are slightly more acidic and reductive in the dry season; ii) there is a moderate inverse Eh-pH Pearson correlation (r = - 0.7); iii) acidic water inside NFP (pH=3.6 $\pm$ 0.2) reflects the low pH of WRP4 effluents and tends to acidify the Consulta Creek downstream of NFP; iv) pH values are 5.8 ± 0.7 upstream of NFP and 4.7 ± 0.3 immediately downstream of NFP. Analyses from Eh-pH diagrams show that sampled locations are transitional environments in which the Consulta Creek waters are more acid than those of other basins. These diagrams also suggest that the more soluble U^{6+} species widely predominates. The UO_2^{2+} species occurs both in NFP and at the two sampling stations immediately downstream, whereas the UO_2OH^+ species predominates at the other stations. Analysis of results indicates acid drainage from NFP and/or directly from WRP4 into Consulta Creek. Detailed investigation in sub-superficial layers is recommended at these locations to evaluate the need of implementing mitigation actions such as lining NFP and constructing hydraulic barriers downstream of the

WRP4. It should be emphasized that the UTM/Caldas operator (Industrias Nucleares do Brasil- INB) is already implementing control measures. We acknowledge funding by CNPq and FAPEMIG, and cooperation from INB.

Keywords: acid mine drainage, uranium mine, water quality, Eh-pH diagram