EFFECTS OF BACTERIAL ACTION ON WASTE ROCK PRODUCING ACID DRAINAGE IN THE BRAZILIAN FIRST URANIUM MINE

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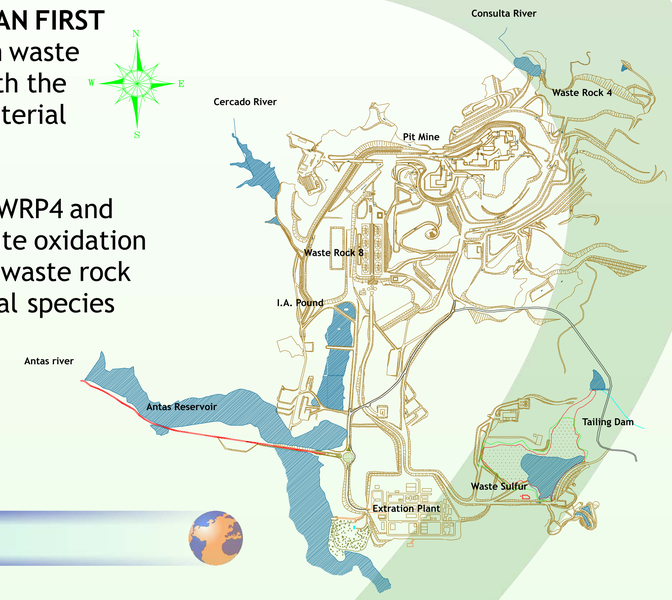
INTRODUCTION

This work is an evolution of the methodology showed in the paper **"STUDY OF WASTE ROCK PILES PRODUCING ACID DRAINAGE IN THE BRAZILIAN FIRST URANIUM MINE", also submitted for INAC2009**. Therefore, the present work also related to the determination of chemical species leaching from waste rock pile 4 (WRP4) of the Uranium Mine and Milling Facility located in the Poços de Caldas Plateau, as well as the generation of acid waters. With the previous experimental setup, it has been observed that not only water and available oxygen are significant to pyrite oxidation reaction, but bacterial activity as well. As a first approach, the present work addresses the same experiment, but now testing without the influence of bacterial action.

Therefore, the new methodology and experimental setup is now capable of determining the acidity of water in contact with material from the WRP4 and the concentration of chemical species dissolved as function of time. Such would also show the extent of bacterial action interference on the pyrite oxidation reaction. Results are based on mass balances comparing concentrations of chemical species in the waste rock before the experiment and in the waste rock plus the remaining water after the experiment. In addition, the evolution of the pH and EMF (electromotive force) values along with chemical species quantified through the experiment are presented through graphics. That is followed by discussions on the significance of such results in terms of concentration of the involved chemical species.

The present work has also shown the need of improving the injection of air into the system. A more sophisticated experimental setup should be assembled in the near future, which would allow the quantification of differences between experimental tests with and without bacterial action.



METHODOLOGY


WRP4 Samples collected


WRP4 Samples separation by size

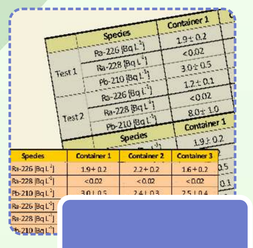

WRP4 Samples sterilization in autoclave


Experimental Setup


Water samples for chemical and bacterial analysis during experiment


Water and material samples for final analysis

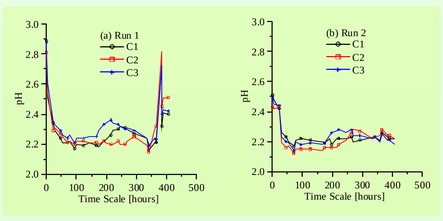

Laboratory analysis


Results

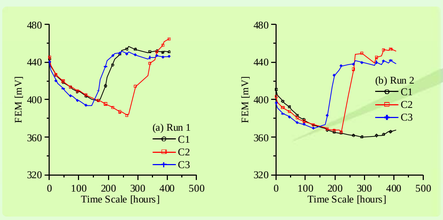
RESULTS

Samples classification

	Particle size between
Test 1	1" (25,4 mm) and 3/4" (19 mm)
Test 2	3/8" (9,51 mm) and 1/4" (6,35 mm)

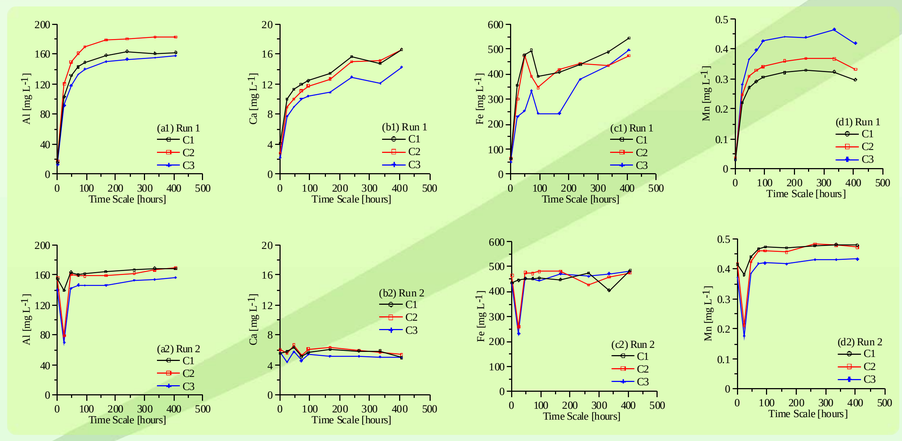


pH variation against time

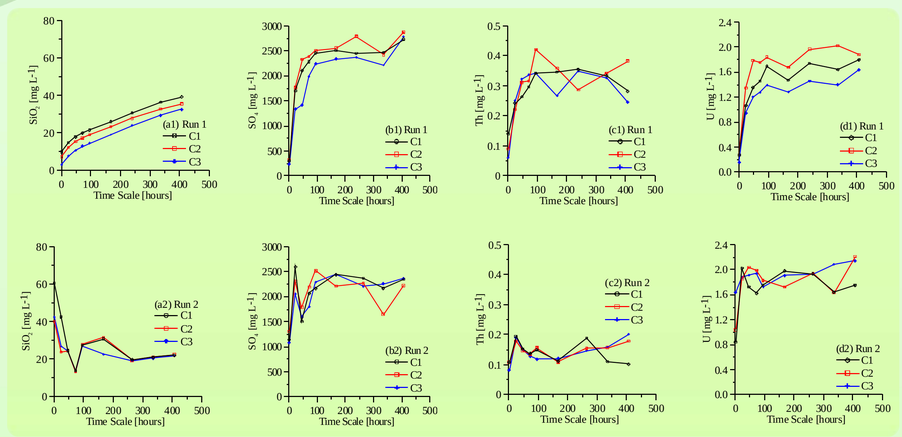


FEM variation against time

WRP4



Analysis results for Al, Ca, Fe and Mn from water samples



Analysis results for SiO_2, SO_4, Th and U from water samples

Radiochemical results from water samples after tests

	Species	Container 1	Container 2	Container 3
Test 1	Ra-226 [Bq L^{-1}]	1.9 – 0.2	2.2 – 0.2	1.6 – 0.2
	Ra-228 [Bq L^{-1}]	< 0.02	< 0.02	< 0.02
	Pb-210 [Bq L^{-1}]	3.0 – 0.5	2.4 – 0.3	2.5 – 0.4
Test 2	Ra-226 [Bq L^{-1}]	1.2 – 0.1	1.9 – 0.2	1.8 – 0.2
	Ra-228 [Bq L^{-1}]	< 0.02	< 0.02	< 0.02
	Pb-210 [Bq L^{-1}]	8.0 – 1.0	1.8 – 0.3	2.9 – 0.5

Results from solid samples before and after tests

	Species	Initial	Final		
			Container 1	Container 2	Container 3
Test 1	Ra-226 [Bq Kg^{-1}]	2711 – 220	2370 – 245	3515 – 282	2050 – 172
	Ra-228 [Bq Kg^{-1}]	230 – 16	180 – 20	200 – 15	211 – 15
	Pb-210 [Bq Kg^{-1}]	2410 – 174	2172 – 152	2670 – 200	1645 – 134
	Al [%]	14.0	11.0	10.9	12.0
	Ca [mg Kg^{-1}]	67.2	0.024	0.020	0.022
	Cl^- [%]	0.134	0.112	0.089	0.089
	Fe [%]	3.34	2.41	1.88	2.08
	Mn [mg Kg^{-1}]	60.4	0.032	0.018	0.023
	SiO_2 [%]	59.9	36.5	44.0	46.4
	SO_4 [%]	6.10	5.46	3.67	4.75
	Th [mg Kg^{-1}]	33.2	37.3	41.0	25.8
	U [mg Kg^{-1}]	63.5	172	80.2	115
Test 2	Ra-226 [Bq Kg^{-1}]	2711 – 220	3800 – 380	3500 – 330	4757 – 434
	Ra-228 [Bq Kg^{-1}]	230 – 16	236 – 175	202 – 17	268 – 30
	Pb-210 [Bq Kg^{-1}]	2410 – 174	3025 – 223	2865 – 213	3937 – 278
	Al [mg Kg^{-1}]	10.3	10.1	10.6	11.0
	Ca [mg Kg^{-1}]	0.014	0.021	0.012	0.020
	Cl^- [%]	0.112	0.134	0.112	0.112
	Fe [mg Kg^{-1}]	1.26	1.33	1.30	1.30
	Mn [mg Kg^{-1}]	0.013	0.003	0.003	0.003
	Si [mg Kg^{-1}]	22.2	21.3	23.1	23.2
	SO_4 [%]	3.63	5.58	4.10	3.82
	Th [mg Kg^{-1}]	35.1	37.4	44.5	34.7
	U [mg Kg^{-1}]	78.6	129	67.7	84.7

CONCLUSION

During the experiment it was noticed that, although each test was carried in triplicate, there was a visible difference in the color of the water inside the containers. For instance, the water in Container 2 became more yellowish. In addition, pH values at Container 2 were slightly lower than the others. Since air from the compressor is divided by a cross-type connection and adjusted by valves, it can be concluded that there was a preferential flow to the central hose connected to Container 2. This preferential flow supplied more oxygen to Container 2 compared to the others, and probably increased the rate of pyrite oxidation reaction. Therefore, in future works, air supply should be more precisely controlled to each container, for example by using individual flow meters.

Moreover, results from either chemical or radiochemical analyses presented an odd behavior, particularly for the samples of solid material before and after each experimental test. Based on the fact that such results are correct, it can be concluded that the samples taken before and after each experimental test had large variations in concentrations. In future works, this issue should be better evaluated.

Another interesting observation is that concentrations of chemical and radiochemical species in water after the experimental tests were much lower than concentrations found in the solid material. This can be explained if the solubility limit of the species in water is also low. In such situation the proportion solid/water should be decreased. In addition, under this low solubility limit situation, precipitation of dissolved chemical species can also occur, even affecting the analysis of either the solid material or the water. Water was filtered in order to analyze only the liquid part for the dissolved species. However, some species could have been dissolved and then precipitated in a new chemical form, staying suspended in water and then being removed by filtering.

Finally, it would be interesting to update the experimental setup taking into account all the improvements suggested before. Four tests are suggested, combining two particle sizes and two biological conditions: sterilized (to eliminate bacterial action) and non-sterilized (to follow bacterial action). Also, another series of experimental tests should be designed to account for the solid/water proportion.

SUPPORT

FAPEMIG
Fundação de Amparo à Pesquisa do Estado de Minas Gerais

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