EU MINE DRAINAGE

RESEARCH EXCHANGE

GENERATION AND PREVENTION OF ACID DRAINAGE IN A URANIUM DEPOSIT

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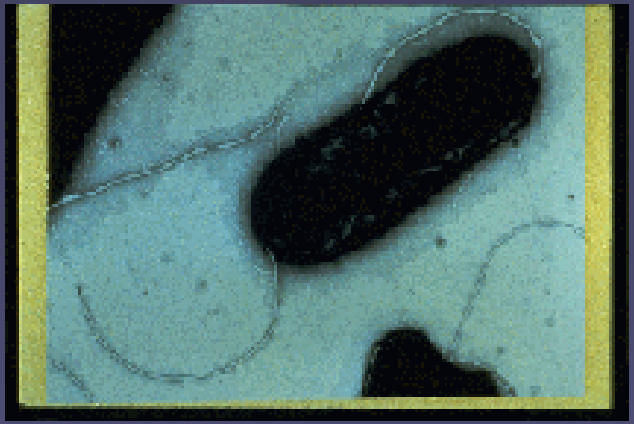
June 11, Freiberg, Germany

Data about the dump effluents before and after the treatment of the dump

Parameters	Before treatment	After treatment	Permissible levels for water intended for use in agriculture and industry
Temperature, ^{0}C	(+5.3) - (+14.0)	(+7.1) – (+15.8)	–
pH	2.44 – 4.15	6.84 – 7.25	6 - 9
Eh, mV	(+398) – (+594)	(-82) – (-235)	-
Dissolved oxygen, mg/l	1.7 – 4.2	0.3 – 0.6	2
Total dissolved solids, mg/l	824 - 2484	378 - 1395	1500
Solids, mg/l	37 - 144	28 - 91	100
Dissolved organic carbon, mg/l	0.5 - 1.2	14 - 46	20

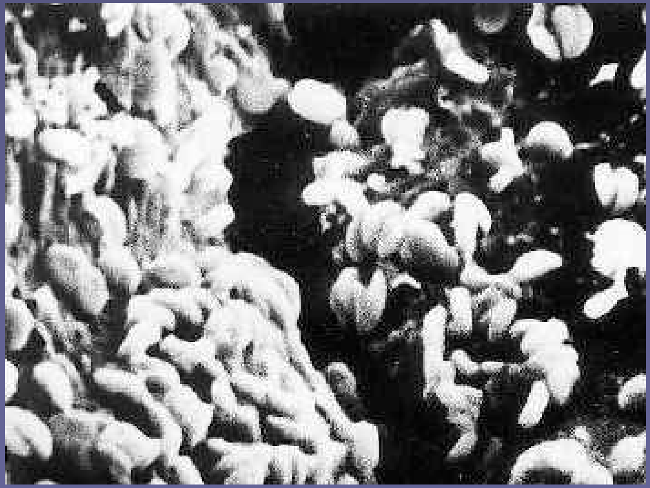
Data about the dump effluents before and after the treatment of the dump (continuation)

Parameters	Before treatment	After treatment	Permissible levels for water intended for use in agriculture and industry
Sulphates, mg/l	440 - 1414	222 - 735	400
Uranium, mg/l	0.35 - 4.06	<0.1	0.6
Radium, βq/l	0.08 - 0.41	< 0.05	0.15
Copper, mg/l	0.82 - 9.14	< 0. 20	0.5
Zinc, mg/l	1.14 - 17.2	0.17 - 1.22	10
Cadmium, mg/l	0.02 - 0.11	< 0.01	0.02
Lead, mg/l	0.17 - 0.68	< 0.10	0.2
Nickel, mg/l	0.35 - 1.45	< 0.20	0.5
Cobalt, mg/l	0.28 - 1.27	< 0.20	0.5
Iron, mg/l	154 - 794	3.2 - 9.5	5
Manganese, mg/l	1.0 - 15.9	0.3 - 1.7	0.8
Arsenic, mg/l	0.07 - 0.37	< 0.01	0.2



Acidithiobacillus ferrooxidans bacteria on a liquid nutrient medium

Colonies of *Acidithiobacillus ferrooxidans* on a solid nutrient medium with a ferrous iron as an energy source



Acidithiobacillus ferrooxidans attached on pyrite

Microorganisms in the dump effluents before and after the treatment

Microorganisms	Before treatment	After treatment		
	2000	2000	2001	2002
	Cells/ml			
Fe^{2+}-oxidizing chemolithotrophs (at pH 2)	10^5 - 10^8	0 - 10^4	0 - 10^1	0 - 10^2
Aerobic heterotrophs (at pH 2)	0 - 10^2	0 - 10^2	0 - 10^2	0 - 10^3
$S_2O_3^{2-}$-oxidizing chemoli- thotrophs (at pH 7)	0 - 10^2	0 - 10^4	0 - 10^3	0 - 10^3
Aerobic heterotrophs (at pH 7)	0 - 10^1	10^3 - 10^6	10^2 - 10^4	10^1 - 10^4
Anaerobic heterotrophs (at pH 7)	0 - 10^2	10^5 - 10^7	10^4 - 10^7	10^3 - 10^7
Sulphate-reducing bacteria	0 - 10^2	10^1 - 10^4	10^2 - 10^5	10^3 - 10^6
Cellulose-degrading microorganisms	ND	0 - 10^2	0 - 10^3	10^1 - 10^4
Denitrifying bacteria	0 - 10^1	10^1 - 10^3	10^1 - 10^4	10^2 - 10^5
Fe^{3+}-reducing bacteria	0 - 10^2	10^1 - 10^4	10^1 - 10^4	10^2 - 10^5
Methanogenic bacteria	ND	0 - 10^2	10^1 - 10^3	10^1 - 10^4
Fungi	0 - 10^1	0 - 10^1	0 - 10^1	0 - 10^2

Bacterial activity *in situ* at different environmental conditions

Sample tested	Before treatment (in 2000)		After treatment (in 2000 – 2003)	
	Fe^{2+} oxidized for 5 days g/l	$^{14}CO_2$ fixed for 5 days, counts/min x ml(g)	Fe^{2+} oxidized for 5 days g/l	$^{14}CO_2$ fixed for 5 days, counts/min x ml(g)
Dump effluents with a pH of 2.1 - 2.8 + Fe^{2+} (9 g/l) at 12 - 18°C	1.25 - 6.84	3200 - 20400	0 - 0.019	0 -45
Dump effluents with a pH of 3.0 - 3.5 + Fe^{2+} (9 g/l) at 12 - 18°C	0.95 - 5.36	2800 - 16700	0 - 0.023	0 - 60
Dump effluents with a pH of 2.1 - 2.8 + Fe^{2+} (9 g/l) at 4 -8°C	0.51 - 1.94	1400 - 7300	ND	ND
Dump effluents with a pH of 2.1 - 2.8 + Fe^{2+} (9 g/l) + $(NH_4)_2SO_4$ (1.0 g/l) + KH_2PO_4(0.2 g/l) at 12 - 18°C	1.72 - 7.10	4400 - 20600	0 - 0.037	0 - 100
Ore suspensions in 9K nutrient medium (with 9 g/l Fe^{2+} and pH of 2.5) at 12 - 18°C	1.54 - 7.52	3900 - 23500	0 - 0.046	0 - 140
Ore suspensions in 9K nutrient medium (with 9 g/l Fe^{2+} and pH of 2.5) at 4 -8°C	0.55 - 2.10	1400 - 6200	0 - 0.007	ND

Conclusions

- The application of a mixture of solid biodegradable organic substrates (cow manure, plant compost, straw) and an alkalizing agent (crushed limestone) was very efficient way to prevent the generation of acid drainage waters in a heap consisting of rich-in-pyrite mining wastes.

- The system created in this way was characterized by an absence of molecular oxygen and slightly alkaline pH, i.e. conditions which prevented the growth and activity of the acidophilic chemolithotrophic bacteria.

- A microbial community consisting mainly of sulphate-reducing bacteria and other metabolically interdependent microorganisms was established in the new system. This new system can exist for a long periods of time if solid biodegradable organic substrates and limestone are added periodically.