In situ biogeochemical barriers for contaminated groundwater treatment near uranium sludge storages

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STUDY OBJECTS

1 - NCCP Novosibirsk
2 - ECP Zelenogorsk
3 - AECC Angarsk
4 - CHMZ Glazov

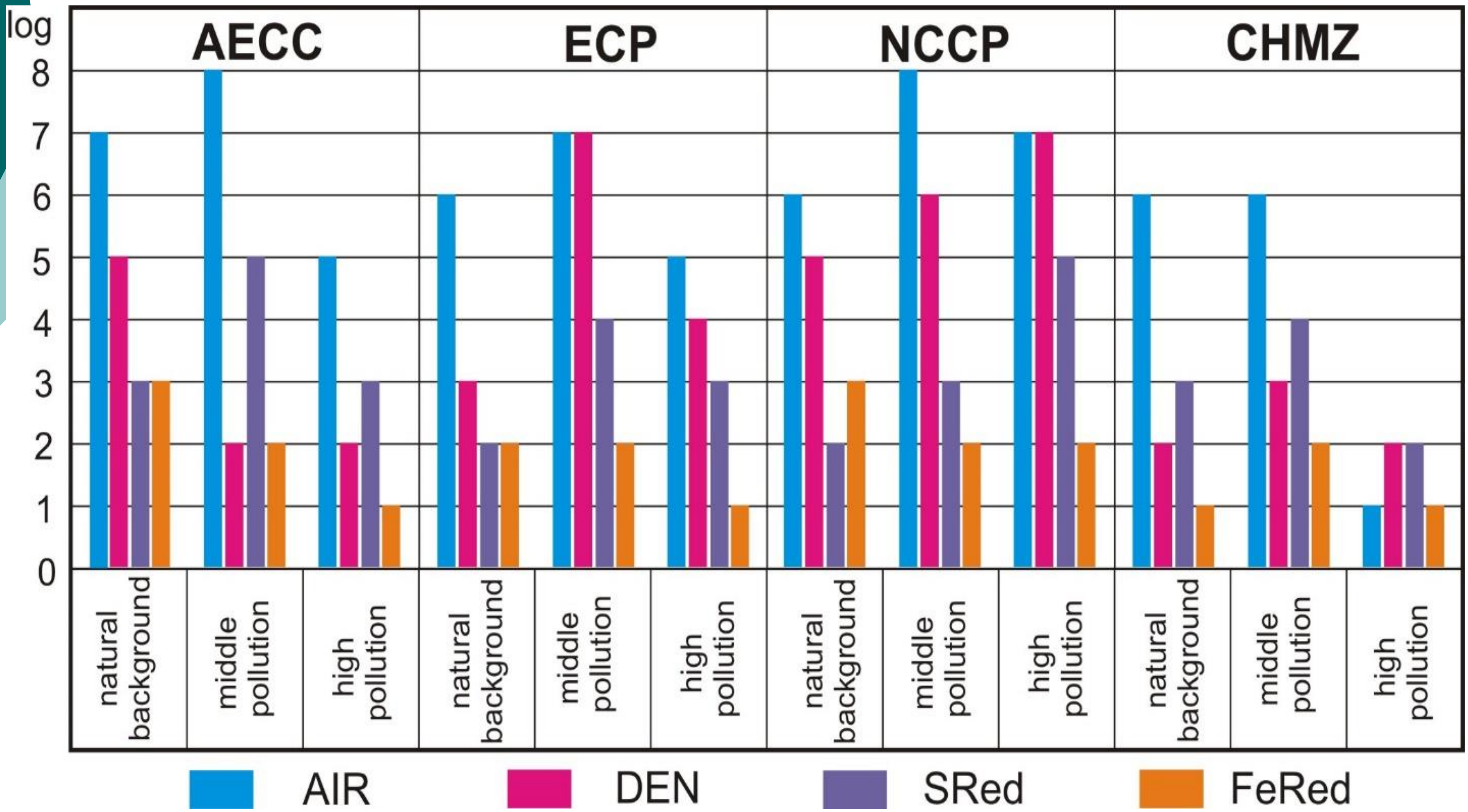
Methods

- The values of Eh, pH, and electric conductivity were determined using a **pH/Ion-meter** (Hanna Instruments, Italy) equipped with various combination electrodes.
- Trace element composition of water was measured by high-resolution inductively coupled plasma mass spectrometry (**ICP-MS**) (ELEMENT FINNIGAN MAT) and inductively coupled plasma atomic emission spectrometry (**ICP-AES**) (IRIS Advantage), anions concentration was determined with a KAPEL®-105M **capillary electrophoresis** system at the analytical center of the Sobolev Institute of Geology and Mineralogy, SB RAS.
- The **laboratory modeling** of biological processes was conducted by adding electron donors and carbon sources (whey and acetate) to groundwater samples and cultivating at ambient temperature. Groundwater (100 mL) was sealed in hermetic vials with a starting air gas phase. Aliquots were taken for analysis every 5–7 days.

CHEMICAL COMPOSITION OF GROUNDWATER IN THE TERRITORY OF SLUDGE STORAGE FACILITIES

		AECC			**ECP**			**NCCP**			**CHMZ**		
		natural	middle	polluted	natural	middle	polluted	natural	middle	polluted	natural	middle	polluted
Eh	mV	115	136	34	166	90	94	-4	-29	57	-70	162	195
pH		7.39	7.10	9.78	7.35	6.70	7.50	7.01	6.51	7.40	7.20	7.80	6.50
Conduct.	mS/sм	0.73	2.35	9.4	0.34	1.86	20.3	0.88	7.1	15.9	0.71	2.90	16.9
CO_3^- + HCO_3^-		96	89	412	267	215	204	393	151	195	54	212	319
SO_4^{2-}		27	1620	3720	0.55	143	800	24.4	1920	590	21.4	1585	780
Cl^-		6.45	49	350	1.61	65	17	21	750	2984	10.9	1131	2260
NH_4		0.28	0.20	103	9.1	16.5	68	1.0	1.1	120	7.8	88	292
NO_3		0.98	45.4	2440	0.80	2330	11500	5.9	900	4740	11.5	3460	7100
Ca^{2+}		33.9	299.1	114.6	77.8	602	5340	103	556	804	132	1113	2940
Na	ppm	5.25	94.22	1519	11.74	70.73	127	12.40	563	2013	100	1058	1549
Mg		18	120	5.0	25	60	120	35	160	72	31	29	76
K		0.72	3.09	139	1.99	5.00	11.0	1.83	8.92	91	16.5	234	47
Si		7.54	7.11	1.27	5.73	5.47	7.00	6.74	1.19	4.87	3.20	12.4	19.7
Al		0.04	0.08	0.13	0.07	0.09	0.09	0.11	0.08	0.13	0.14	2.4	3.1
Fe		13.9	1.66	3.33	1.59	2.03	15.4	5.26	3.46	2.65	1.40	5.10	67
Mn		0.41	0.07	0.81	1.1	0.73	2.2	1.3	2.1	2.5	0.83	1.0	2.4
P		0.20	0.31	1.16	0.40	1.29	10.0	0.53	0.47	0.07	0.01	0.01	0.39
U	ppb	0.09	0.24	0.26	0.23	3.0	5.6	2.0	0.86	3422	0.01	1.90	4930

MICROBIAL POPULATIONS (LOG CELL NUMBER/ML) IN GROUNDWATER SAMPLES



THE RATE OF NITRATE AND SULFATE REMOVAL IN GROUNDWATER SAMPLES AFTER STIMULATION OF THE MICROBIAL COMMUNITY

The media		**Duration of NO_3^- decomposition, days**	**Rapidity of NO_3^- decomposition, ppb/day**	**Duration of SO_4^{2-} decomposition, days**	**Rapidity of SO_4^{2-} decomposition, ppb/day**
AECC	natural	0	0.08	12	27*
	middle	5	1.5	30	324
	polluted	20	32.5	75	186
ECP	natural	0	0,8*	0	0,55*
	middle	25	58.2	40	5.7
	polluted	180	54.8	210	4.4
NCCP	natural	0	0.8	7	25*
	middle	7	20	45	274
	polluted	75	36.4	130	7.9
CHMZ	natural	0	0.8	14	21*
	middle	45	38.4	90	1585
	polluted	90	54.6	130	780

Conclusions

- Study shows that using the proposed approach partial or full decrease of uranium, ammonium nitrate, and other compounds distribution can be reached at all sites.
- While the production facilities are being operated, injection of reagents for the sustainable development of biogeochemical barrier should be carried out with a frequency sufficient to change the compounds into solid (U, S), as well as gaseous (N) phases.
- After decommissioning and preservation of the facilities, it is necessary to provide for a margin of stability of barriers, so that they prevent its degradation by background water, which will gradually replace contaminated technogenic solutions.

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THANK YOU