

Evaluation and survey of a radiologically contaminated legacy site in Vienna

Fabian Rechberger
Austrian Agency for Health and Food Safety (AGES)

Department of Technical Radiation Protection

Historical Usage of Uranium

- ↪ Discovery of radioactivity → uranium ore/pitchblende residues
- ↪ Austria: Joachimsthal mine (CZ)
- ↪ Marie Skłodowska Curie: discovery of radium and polonium in the tailings of the uranium colour production in Joachimsthal
- ↪ Pitchblende → production of Radium
- ↪ Ra-226 + progeny
 - Rn-222
 - Pb-210 and Po-210

Historical Usage of thorium

- ↪ Monazite sands → production of Thorium
- ↪ Carl Auer von Welsbach inventor of the incandescent light mantle
– also called the 'Welsbach mantle'
- ↪ Th-232 + progeny
 - Ra-228
 - Rn-220 (thoron)
- ↪ Several production sites in Austria (Vienna)



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Anton on wikipedia.de

Initial situation in Austria

↪ Bullet points according to EU-BSS
(Section 6, Art. 100/101/102)

↪ Member States shall assign responsibilities for:

- Implementation of strategies for the management of existing exposures
- Coordination between relevant parties
- Evaluation of remedial and protective measures
- Provide information to exposed populations on potential health risks

Dose limits:

Individual members of the public: 1 mSv/a

Occupationally exposed worker category A: 20 mSv/a

Occupationally exposed worker category B: 6 mSv/a

Plan of action



1. Identification of NORM legacy sites
2. Characterization of the legacy sites
3. Secure/decontaminate the site
4. Waste management strategy

Identification



- Competent authority: BMNT (Federal Ministry for Sustainability and Tourism)
- Identification of legacy sites (research) ➡ legacy catalogue
- Prioritization based on radiological risk for population
- Confirmation of contamination and evaluation of its extent (AGES)

Characterization



↪ Characterization

- Nuclides (Th/U)
- Spatial Distribution
- Exposure scenario (if necessary: simulations)

↪ Cooperation with specialists for chemical legacy sites

↪ Correlation between chemical and radiological contamination?

Remediation of contaminated sites

Decision-making

Secure legacy site or decontamination?

- Size of the area
- Solubility of material
- Indoor/outdoor
- Use of site? (residence time)

Secure

- Preservation of evidence (continuous sampling / monitoring system)
- Stable contamination profile
- Documentation for future generations (radiation protection)

AGES in action



Status



What has happened until now?

- ↪ 1st characterisation 2013
- ↪ 2nd characterisation and necessary immediate actions 2014 (exchange of soil)
- ↪ Characterisation in cooperation with specialists for chemical legacy sites April 2016
- ↪ Sampling of core drills May 2016
- ↪ Erection of a dog zone ~September 2016
- ↪ Characterisation of the dog zone October 2016
- ↪ Establishing further measurements and plan of action 2017
- ↪ Monitoring program (phase 1) 2017-2019

Characterisation

Correlations?

Coefficient of determination		Element Specification (ICPS/NUA)						
		Antimony	Arsenic	Barium	Lead	Cadmium	Chromium	Cobalt
Gamaspectrometrie	Th-232	0.44	0.66	0.38	0.43	0.36	0.14	0.22
	Ra-226	0.82	0.60	0.68	0.75	0.68	0.11	0.36
		Molybdenum	Sodium	Nickel	Mercury	Tin	Zinc	Cerium
	Th-232	0.02	0.61	0.13	0.42	0.39	0.18	0.42
	Ra-226	0.18	0.30	0.23	0.58	0.71	0.32	0.40
		Potassium	Copper	Manganese	Beryllium	Thorium	Uranium	
	Th-232	-0.02	0.34	-0.19	0.50	0.94	0.71	
	Ra-226	-0.13	0.66	-0.11	0.73	0.84	0.38	

- ☞ Coefficients of determination between activity concentration and concentration of the elements in the probed areas

Monitoring Program

Summary



- ☞ 20 surface samples (max. activity concentration 1.1 Bq/g)
- ☞ 5 profile samples with 3 soil layers at different depths
- ☞ 2 vegetation samples
- ☞ 8 water samples
- ☞ Dose rate measurements (twice/yr)

Sample point	Depth	Th-232 (Bq/kg)	Ra-226 (Bq/kg)
Sample drmp 3	0-10 cm	152 ± 14	49 ± 5
	10-20 cm	161 ± 14	54 ± 5
	20-30 cm	136 ± 12	45 ± 5
Sample drmp 24	0-10 cm	74 ± 7	40 ± 4
	10-20 cm	55 ± 5	30 ± 3
	20-30 cm	145 ± 13	35 ± 4
Sample drmp 23	0-10 cm	104 ± 10	57 ± 6
	10-20 cm	123 ± 11	62 ± 6
	20-30 cm	2864 ± 241	1188 ± 107
Sample drmp 20	0-10 cm	30 ± 3	48 ± 5
	10-20 cm	30 ± 3	46 ± 5
	20-30 cm	91 ± 9	176 ± 16
Sample drmp 7	0-10 cm	499 ± 43	230 ± 21
	10-20 cm	742 ± 63	349 ± 32
	20-30 cm	735 ± 62	320 ± 30

Monitoring Program

Dose rate measurements

Dose rate measurement point	Dose rate 1st Quarter ($\mu\text{Sv/h}$)	Dose rate 4th Quarter ($\mu\text{Sv/h}$)	Dose rate measurement point	Dose rate 1st Quarter ($\mu\text{Sv/h}$)	Dose rate 4th Quarter ($\mu\text{Sv/h}$)
1	0.3	0.35	14	0.25	0.27
2	0.2	0.18	15	0.1	0.15
3	0.34	0.2	16	0.19	0.3
4	0.17	0.2	17	0.53	0.5
5	0.64	0.7	18	0.2	0.15
6	0.12	0.13	19	0.5	0.5
7	0.43	0.8	20	3.1	3.5
8	0.26	0.29	21	0.36	0.4
9	0.11	0.14	22	1.8	2
10	0.5	0.66	23	0.97	1.6
11	0.29	0.32	24	0.28	0.4
12	0.25	0.17	25	0.3	0.4
13	0.1	0.12	26	0.62	0.65



Monitoring program

Results groundwater



Well	Sampling date	ICPMS			LSC		
		U-238 (Bq/l)	U-238 (µg/l)	Th-232 (Bq/l)	gross α/β (Bq/l)	Ra-226 (Bq/l)	Ra-228 (Bq/l)
101/18	18.04.2018	0.041 ± 0.004	3.3 ± 0.3	<0.0020	0.40 ± 0.10	<0.0058	0.050 ± 0.013
102/18	18.04.2018	0.318 ± 0.032	25.8 ± 2.6	<0.0020	1.58 ± 0.28	<0.0048	<0.010
101/18	13.06.2018	0.035 ± 0.003	2.8 ± 0.3	<0.0020	<0.585	0.0092 ± 0.0025	<0.016
102/18	13.06.2018	0.535 ± 0.053	43.3 ± 4.3	<0.0020	2.10 ± 0.26	0.0102 ± 0.0027	<0.019
101/18	14.08.2018	0.035 ± 0.004	2.7 ± 0.3	<0.004	<0.426	<0.0029	<0.014
102/18	14.08.2018	0.470 ± 0.047	35.8 ± 3.6	<0.004	1.45 ± 0.20	<0.0022	0.014 ± 0.006
101/18	29.10.2018	0.025 ± 0.003	2.0 ± 0.2	<0.004	0.62 ± 0.30	<0.0054	0.031 ± 0.014
102/18	29.10.2018	0.342 ± 0.034	27.7 ± 2.8	<0.004	1.57 ± 0.25	<0.0037	<0.019
GW_Gardener	09.04.2019	<0.001		<0.0004	0.524 ± 0.23	<0.0021	<0.021

- ↪ 1st water-bearing layer ~5 m (no drinking water)
- ↪ Freshwater gardener (~ 50 m): drinking water/watering plants
- ↪ TWV parameter guidance level: 15 µg/l U-238
- ↪ Dose estimation: <0.1 mSv/yr

Results: Monitoring Program

What did we learn?

- ☞ Plan of action ✓
- ☞ Characterisation ✓
- ☞ Cooperation with specialists ✓
- ☞ Decision made based on results ✓
- ☞ Monitoring Program ✓
- ☞ ...2019 and beyond

ENA Conference

Vienna



ENA Conference 20th-22nd October 2020 VIENNA

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