



RadoNorm
Managing risks from radon and NORM

Expectations and experiences regarding radiation protection during geothermal operation

UHasselt: Wouter Schroeyers, Linde Pollet

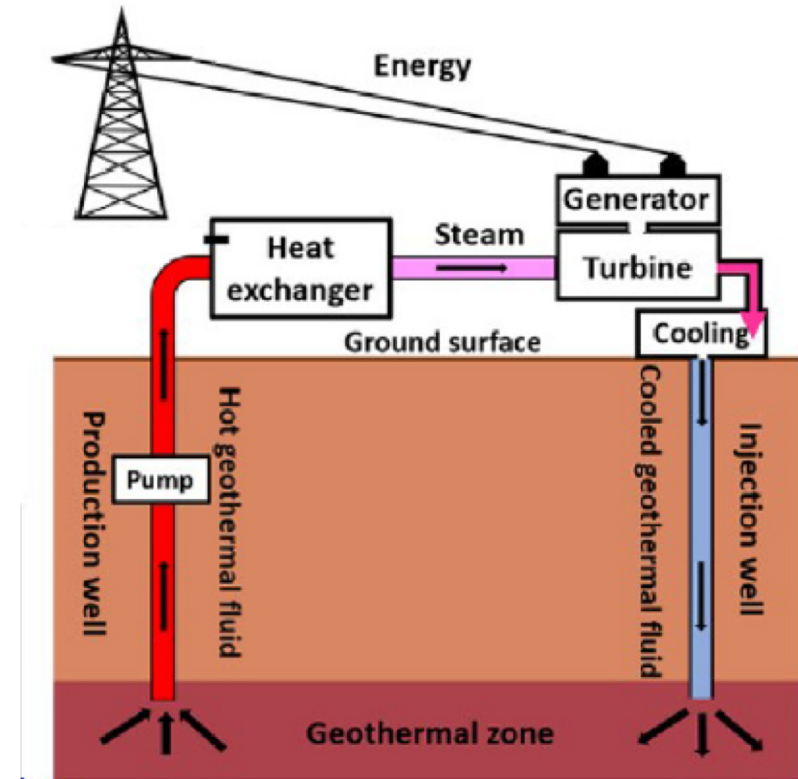
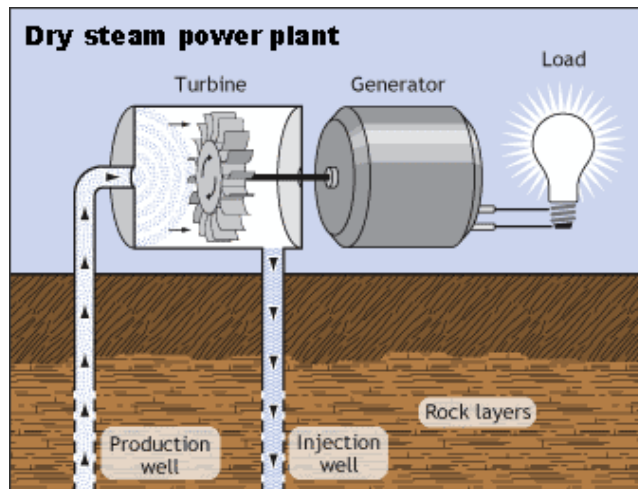
SCK-CEN: Robbe Geysmans, Tanja Perko

Ricomet 2023, Workshop Managing NORM in geothermal installations, 31/08



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Dry steam - hot water - steam & hot water geothermal operations



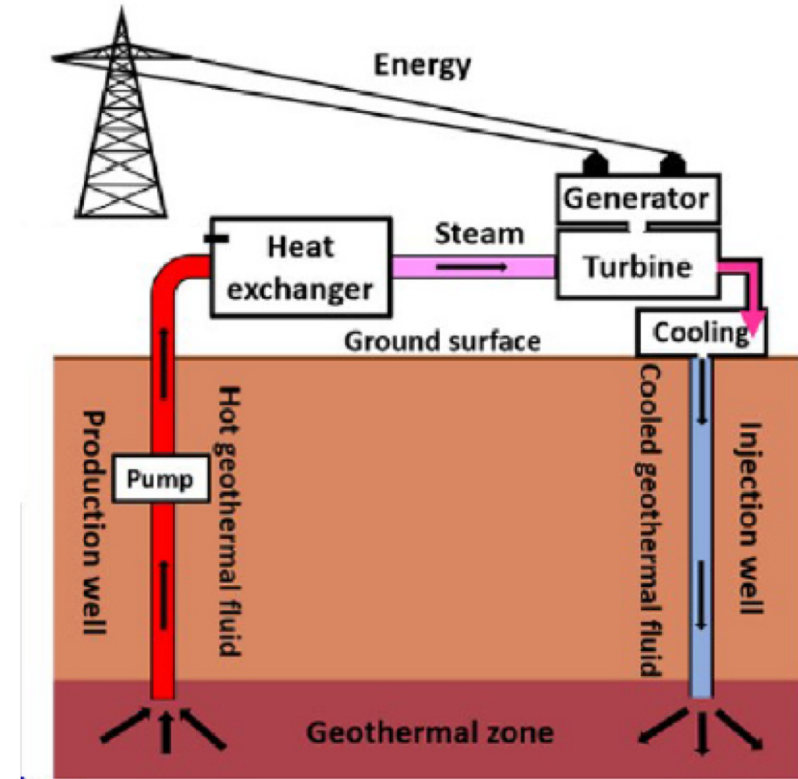
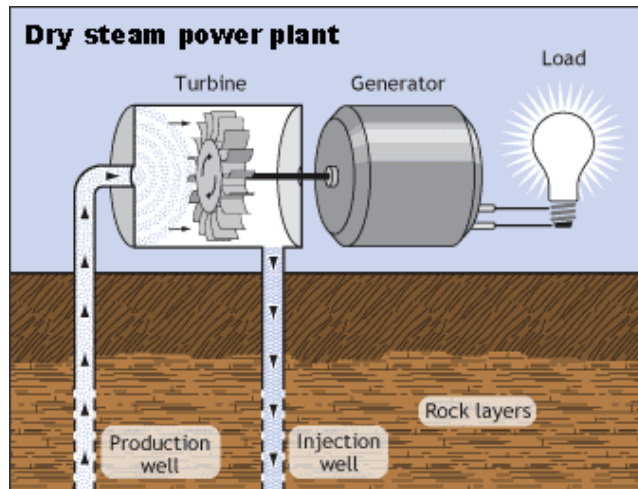
Sources: Shinonaga et al., *International Journal of Hygiene and Environmental Health* 248 (2023) 114061
U.S. Department of Energy, Geothermal Technologies Office (www.eia.gov)

Dry steam - hot water - steam & hot water geothermal operations

Unsear 2016

(Sources, effects and risks of ionizing radiation)

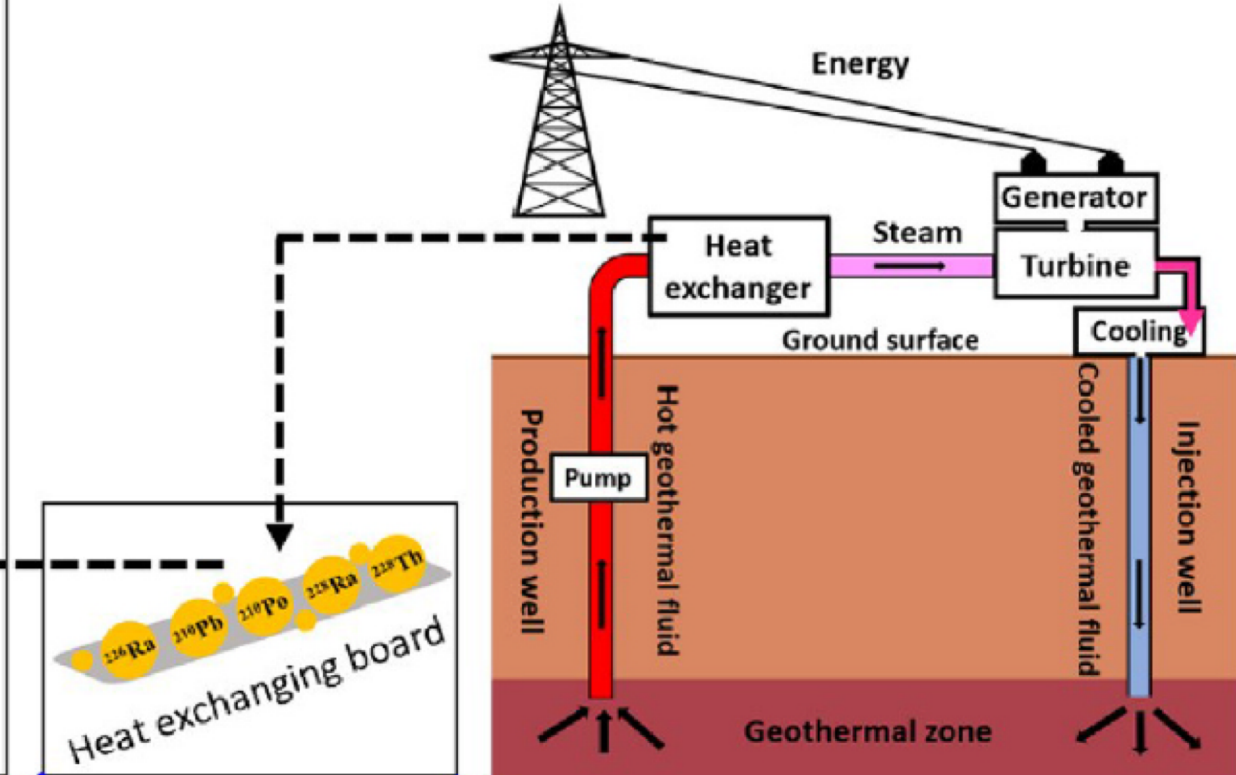
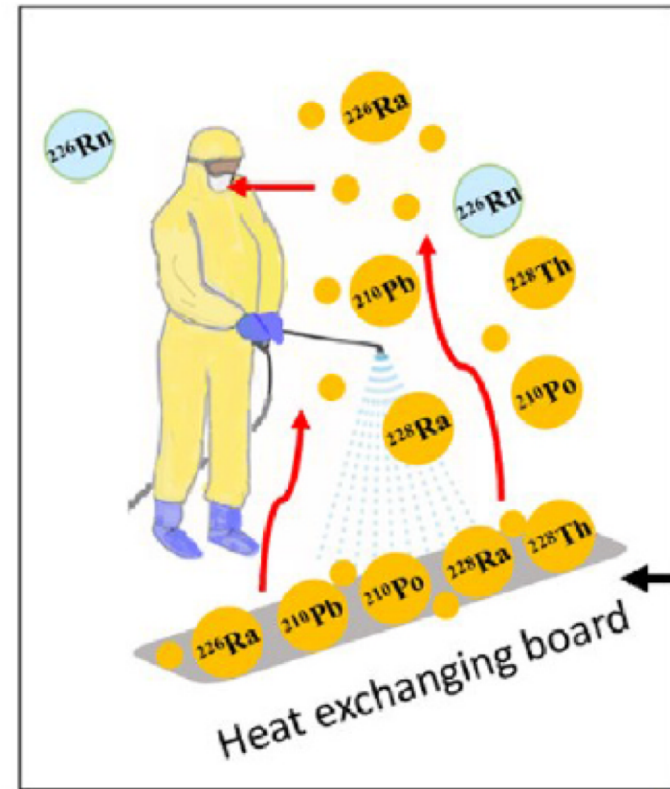
- **Geothermal energy:**
 - Emission rate ^{222}Rn : 150 TBq/(GW a)
(Larderello, Italy & 'The Geysers', California)
 - Public exposure: 1 -20 manSv/(GW a)
Low – average population density
 - Worker exposure: 0.05 man Sv/(GW a)



**Radon release: gases vented
(dry steam condensation units)**

Sources: Shinonaga et al., *International Journal of Hygiene and Environmental Health* 248 (2023) 114061
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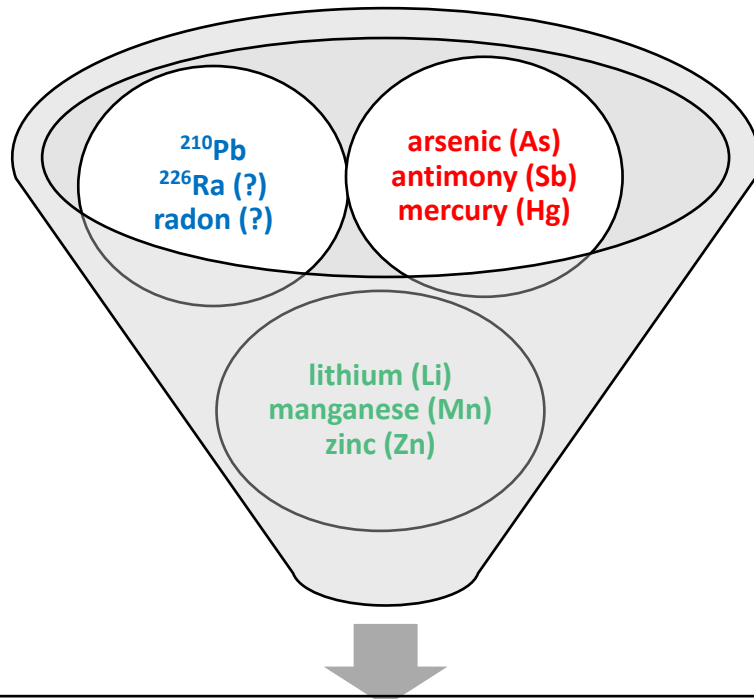
Exposure of workers during geothermal operations



Additional exposure cleaning:
➤ 323 $\mu\text{Sv/y}$ (radon: 297 $\mu\text{Sv/y}$)
(working time: 170 h, 4 times
cleaning a week, protective clothing)

Source: Shinonaga et al., *International Journal of Hygiene and Environmental Health* 248 (2023) 114061

Multipollutant exposure



*Risks for polluting surface and groundwater, soils and sediments?

*Hazards for workers?

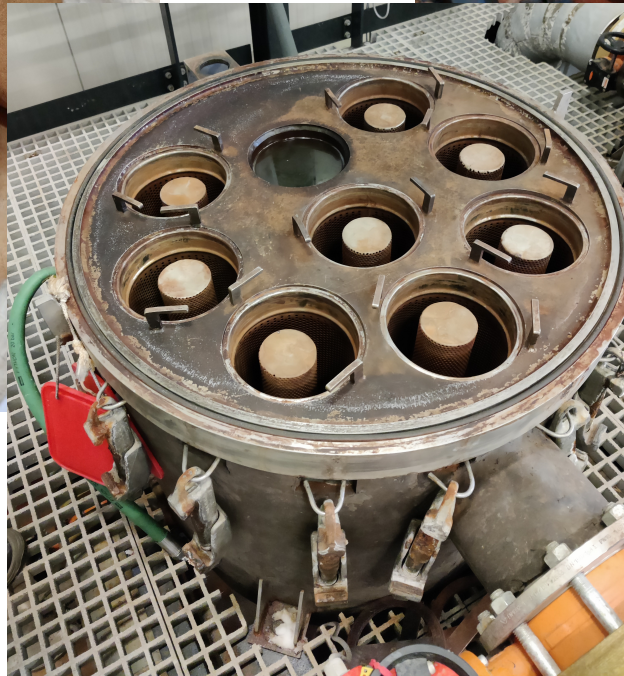
- Region, geological formation?
 - Type of rock, depth, temperature?
- Installation?
 - Flow rate?
 - Materials used (carbon steel / epoxy)?
- Waste type?
 - Filter type (candle, bag, filter dimensions,...)?
 - Location in the installation? (hot or cold)
 - Frequency of filter exchange?
 - Radon issues?

Sources: Capocelli, et al., 2020. 'Reuse of waste geothermal brine: process, thermodynamic and economic analysis'. *Water* 12, 2–19
 Van Bochove et al., 2022, presentation 'Radioactive waste management in Dutch geothermal sector' NORM X conference, Utrecht

Radiation protection for workers

- Training the **safety culture** for maintenance workers dealing with multipollutant scenarios? **Risk awareness**?
- **Radon issues** sufficiently well known for protection of workers?
Present in areas only accessed during maintenance?
- Options for **prevention** of scale formation?
- Limited number of experimental studies. Are the specific cases that form the scientific basis of radiation protection regulation **representative** for the geothermal sector?

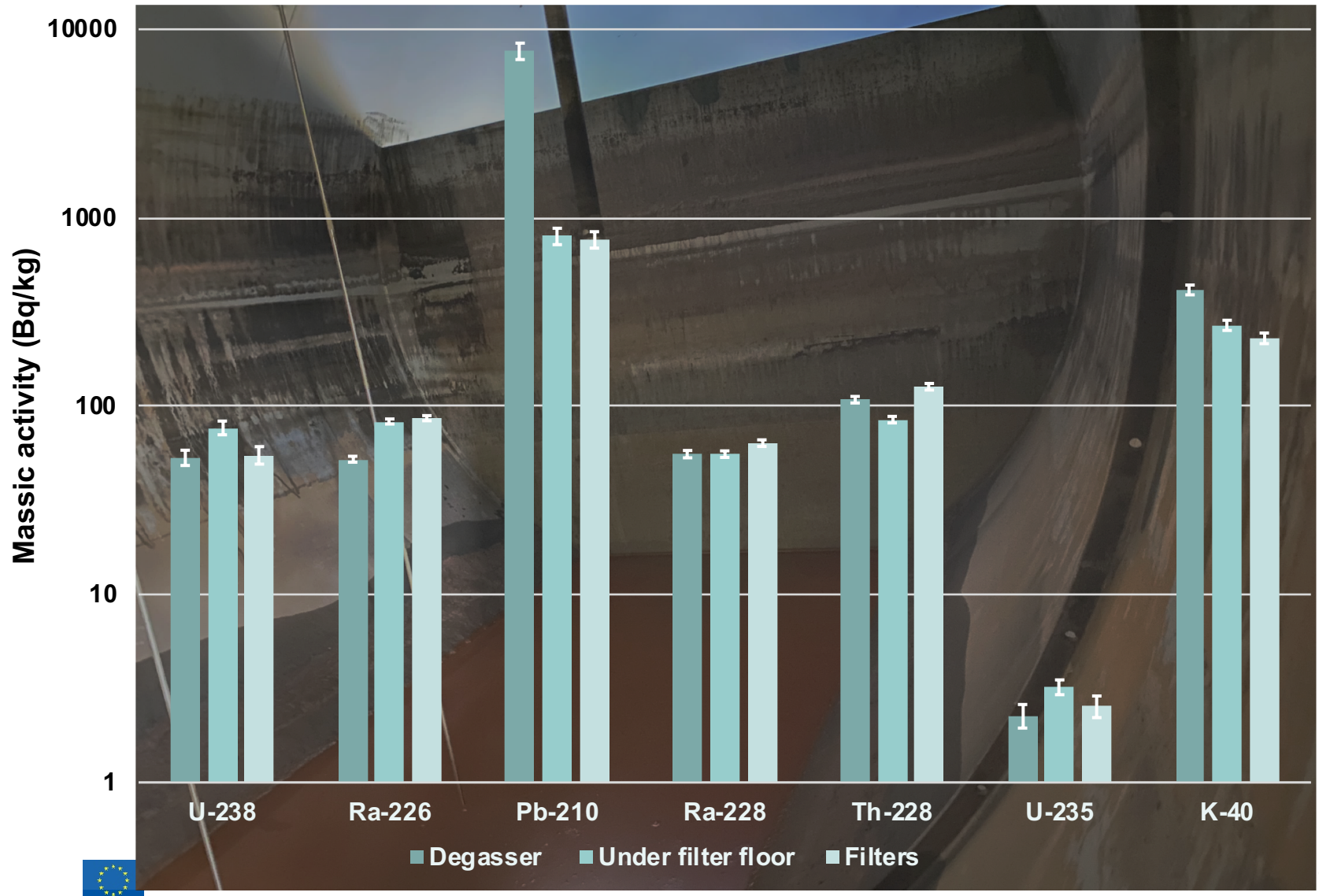
During operation



During maintenance



Massic activity of samples during maintenance



Decommissioning

- Information of prospective study in Balmatt site



Washable filters

Costs?

Recycling

Future proof?

Prevention →
epoxy coating

Extraction of rare
earth elements
(REE)

Thanks for your attention!

