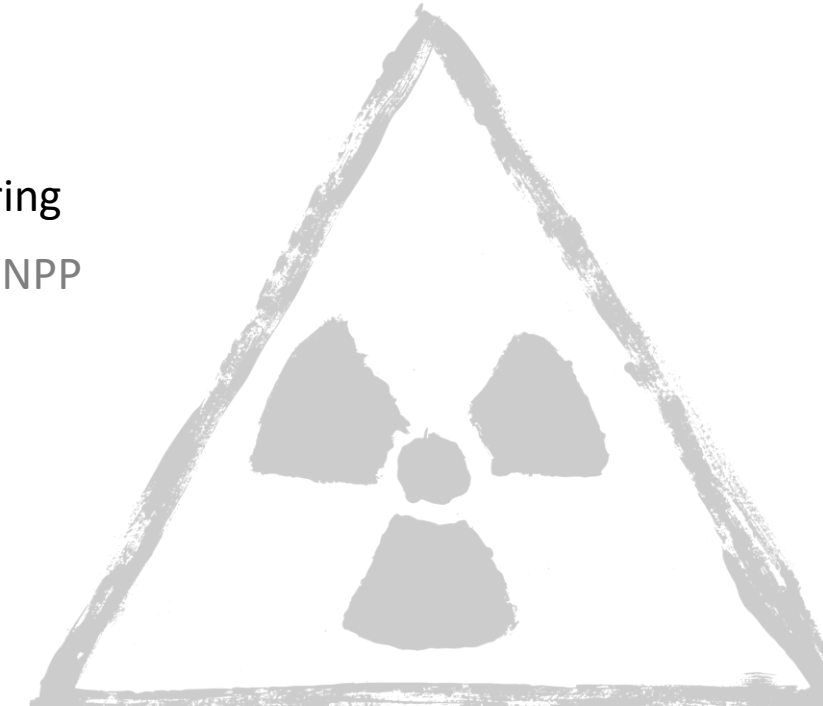
Current status of the Croatian national programme

Galla Uroić, mag. ing. min.

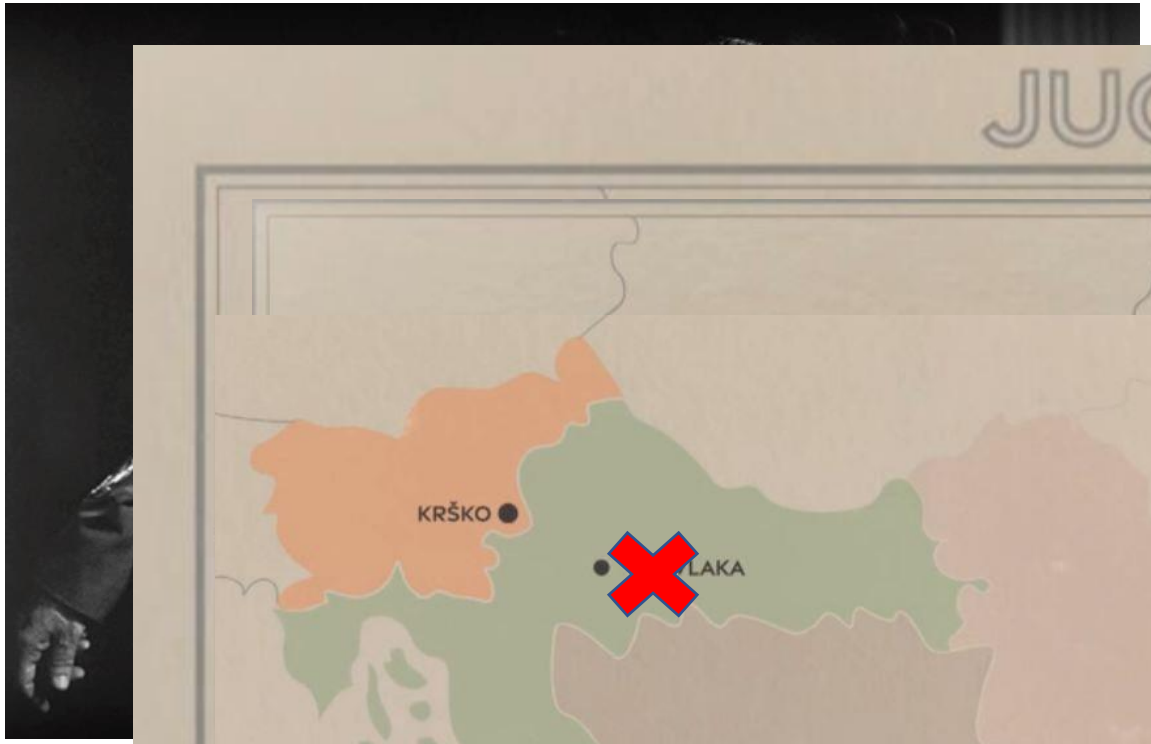
Faculty Of Mining, Geology, and Petroleum Engineering

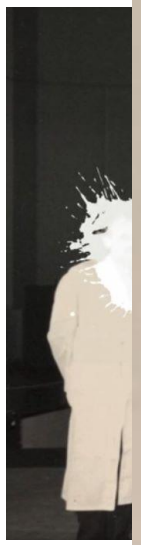
Fund for financing the decommissioning of the Krško NPP



University of Zagreb

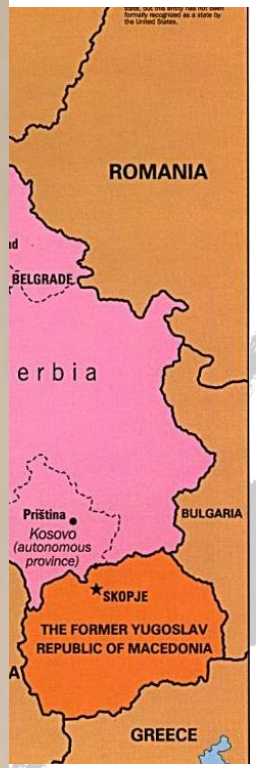
A short history lesson…





- Josip Broz Tito

avia



BACK TO THE FUTURE™

Krško Nuclear Powerplant

- Construction began: 1975
- Connected to power grid: 1981
- Commission date: January 1st, 1983
- built as a joint venture by Slovenia and Croatia which were at the time both part of Yugoslavia
- operating company Nuklearna elektrana Krško (NEK) is co-owned by the Slovenian state-owned company Gen-Energija and the Croatian state-owned company Hrvatska elektroprivreda (HEP)
- NEK provides more than one-quarter of Slovenia's and 14% of Croatia's power

- 2 loop PWR , Westinghouse
- fuel: UO2 (121 FE) 18 month fuel cycle
- 727/696 MWe (gross electrical power/net electrical
- final shutdown planned originally for 2023 prolonged till 2043

Radioactive waste we have to deal with…

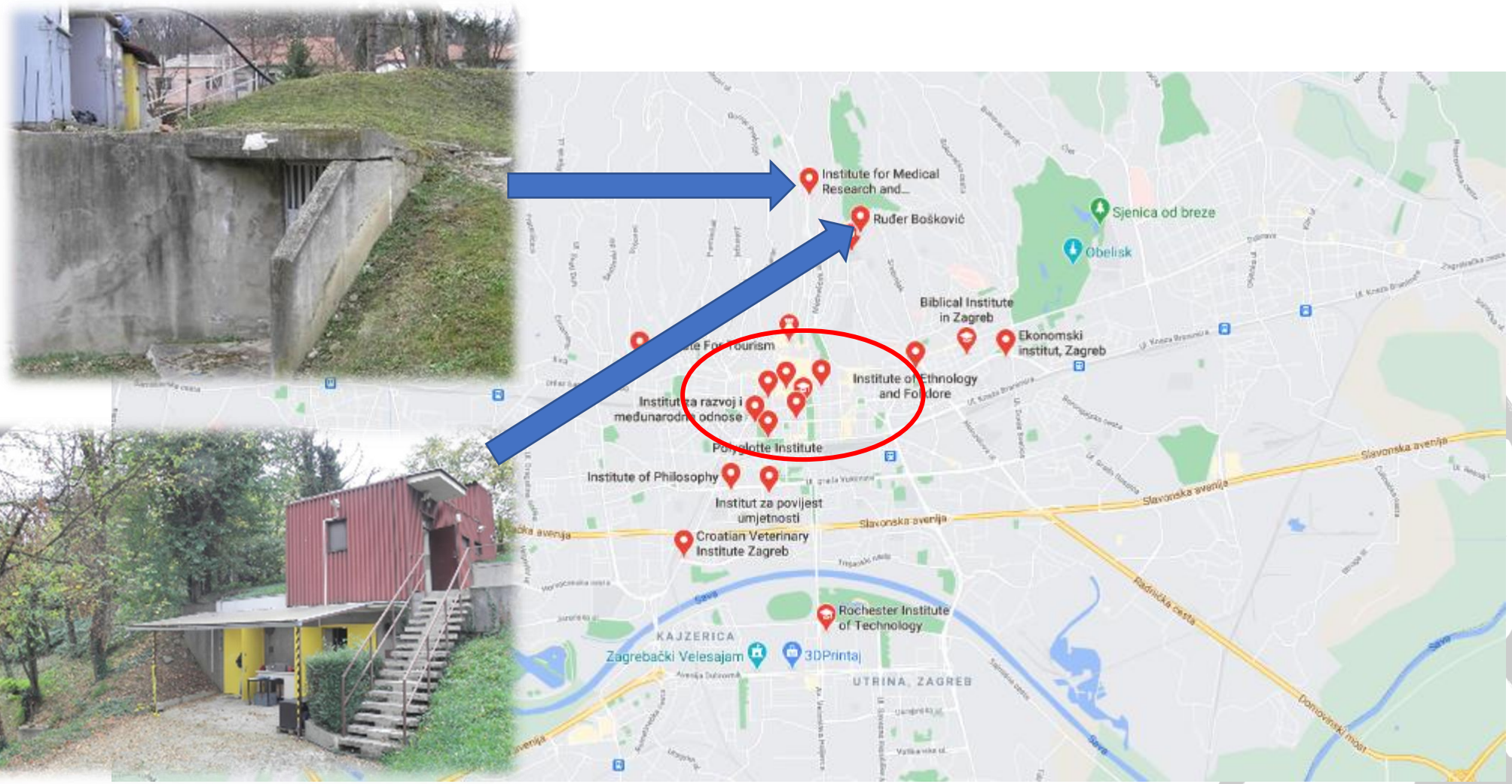
- Institutional waste
- Low and intermediate level waste
- Spent nuclear fuel

Institutional waste in Croatia

- 60 years of medical, research, industrial, military and public application of radioactive sources
  - Interim storages in the 2 institutes (closed and remediated)
  - Small temporary (interim) storages at users/generators site

RW and DSRS type	Current volume and activity		Expected volume and activity in 2060	
Short lived	7,53 m^3	1,28 TBq	100,0 m^3	24,0 TBq
Long lived	3,81 m^3	2,05 TBq		3,0 TBq
Total	11,34 m^3	3,33 TBq	100,0 m^3	27,0 TBq

Two closed storage facilities

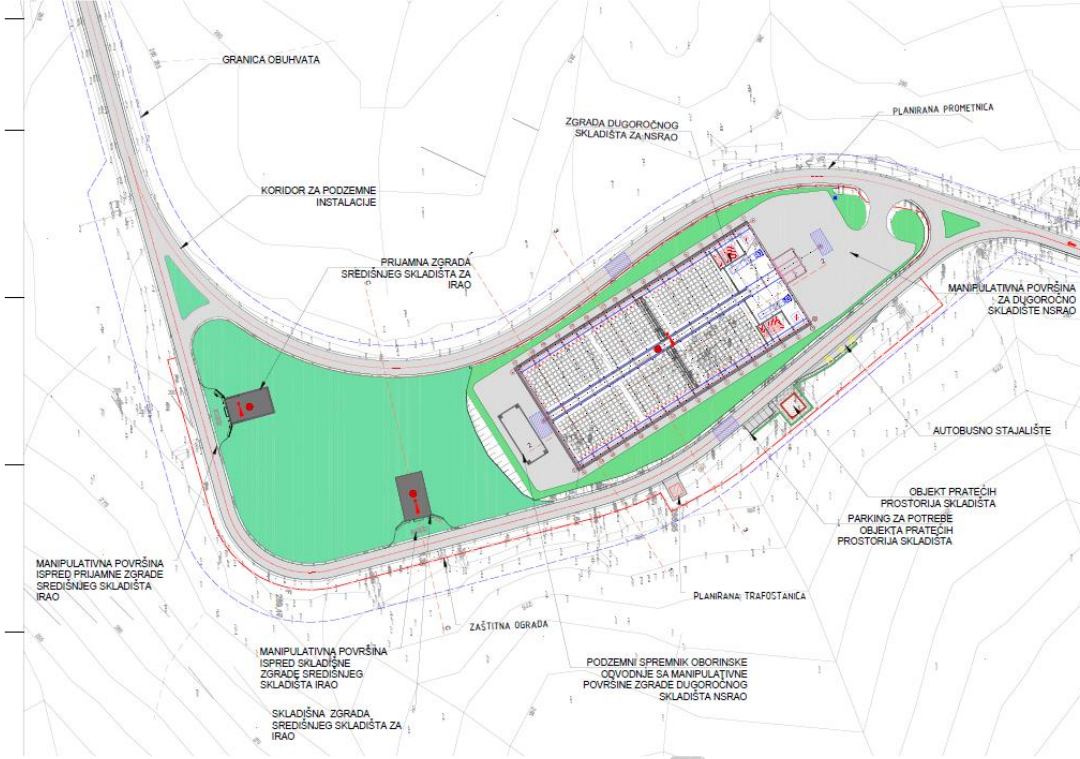


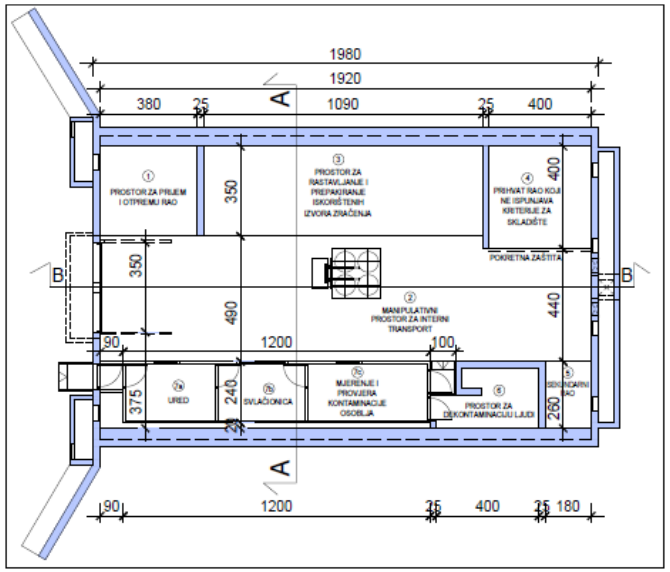
Two closed storage facilities

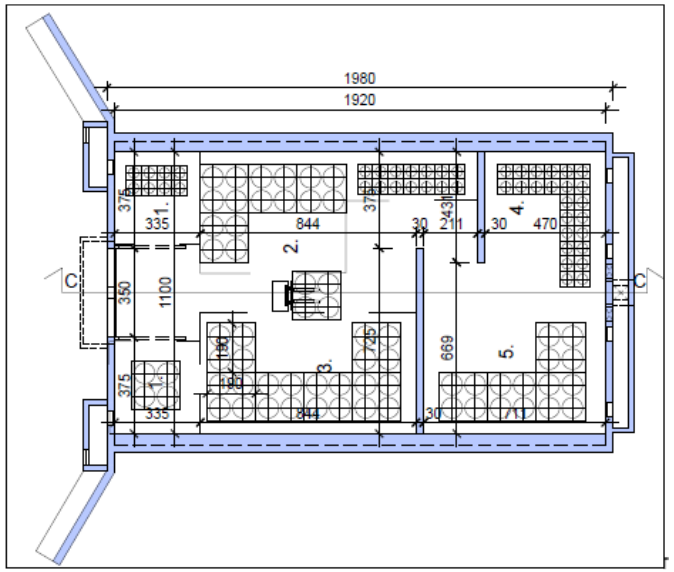
Planned long term storage facility

- Central storage for institutional RW and DSRS - reconstruction of existing arch storage objects and infrastructure upgrade
- Administrative building
- Info-centre
- Prepared: (preliminary) design solution

Čerkezovac site on " Trgovska gora " area



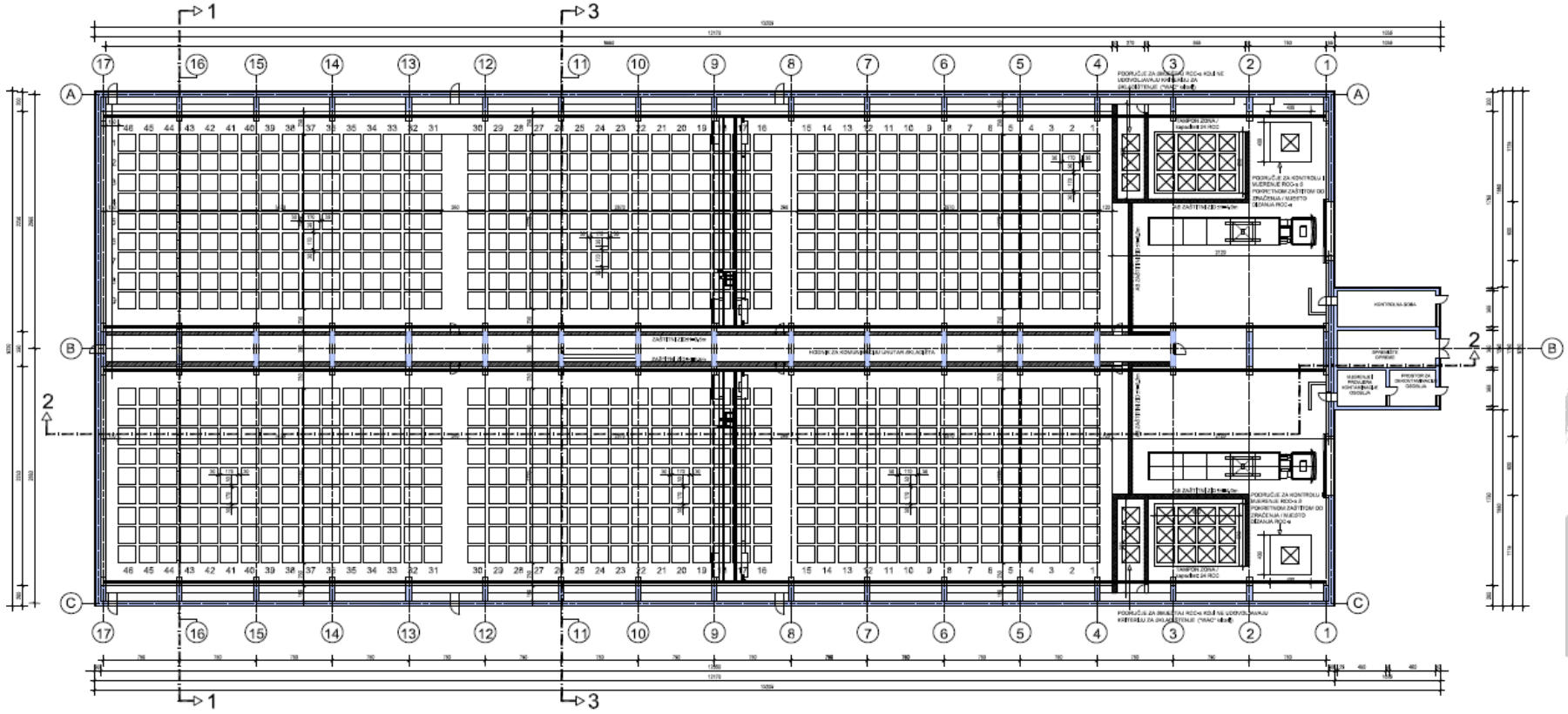




Central storage for institutional RW and DSRS

Long-term storage for Krško NPP operational LILW

- New, one-store building with auxiliary objects
- Treatment and conditioning of LILW in multipurpose Reinforced Concrete Container (licensed for transport, storage and disposal) in appropriate treatment facility in EU
- RCC placed in three levels



Current activities - RWM Centre

- Center establishment activities– obtaining a location and building permit
  - Field work (investigation work) - 19 months long and includes: geological research, hydrogeological and hydrological research, geophysical research (tomography, seismic surveys,…), field research (tracing, drilling, mapping...), engineering geology (rock analyzes…)
  - Determination of existing radioactivity state - at the location and municipality Dvor, including calculation of radiation doses for population. Sampling and measurements includes: surface water and fish, spring, well and groundwater, soil, food from farms, honey and other bee products, wildlife and organisms from forest systems, air and precipitation, installed passive dosimetry systems and measuring stations at Čerkezovac (air sampling station, totalizer, ambient dose rate measurement system).
  - Designing (preliminary design, main design, feasibility study of the project), safety assessment and environmental impact assessment

Current activities - RWM Centre

- Seismic surveys
  - Seismographic station (digital seismograph and accelerograph) installed on location of the Center - for the needs of continuous monitoring, transmission and analysis of the obtained data
  - Based on the parameters obtained by measurement - preparation of a seismotectonic study and seismic hazard study for the area of the Čerkezovac site
- Demining
- Transport study – provide insight into the current condition of the roads and access roads to the Centre and suggest possible necessary reconstruction

Information and education centre Dvor

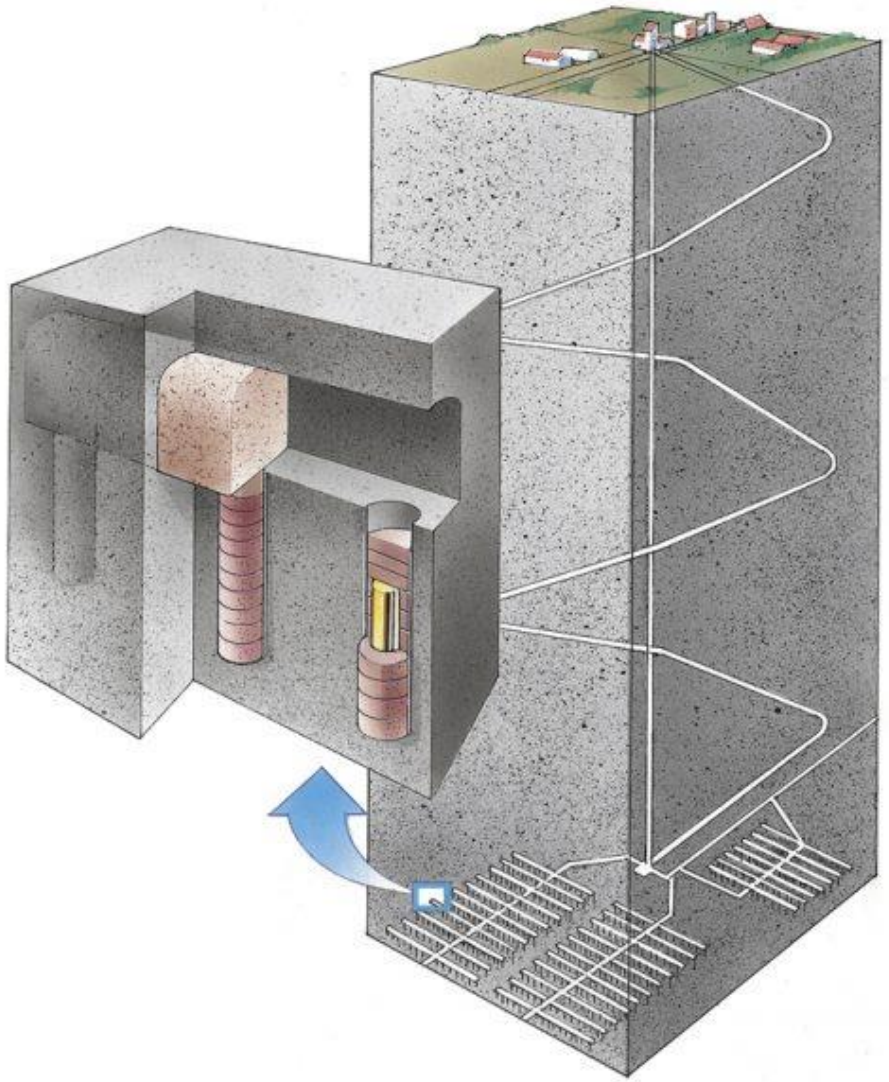
Spent fuel dry storage

- **NPP Krško**
- Total number of 2,282 fuel assemblies estimated until 2043
- SF dry storage at Krško NPP site
- Construction 2020/21
- Operation starts 2023
- License for 60 or more years
- Holtec casks

SF and HLW disposal – shared responsibility

- Joint SF/HLW Disposal Project (Cro & Slo) or multinational solution
- Baseline scenario: deep geological repository at suitable location in Croatia or Slovenia
- Reference disposal concept: SKB KBS-3V model
- Another disposal concept???

- Or Multinational Solutions - ERDO Association – Deep borehole?!?!?



Research in Croatia…

4 projects:

- **P1 - In-situ simulation of thermo-hydro-mechanical effects on the host rock and buffer material**
- P2 - Permeability and diffusion of Tritium in bentonite
- P3 - Analysis of possibilities for disposal of spent nuclear fuel and/or high-level radioactive waste in deep boreholes
- P4 - Preliminary analysis of possibilities and regulatory foundations regarding potential geological environments for the construction of a deep geological repository

+ Galla's PhD 🤔

Funded by:
Fund for financing the decommissioning of the Krško Nuclear Power Plant and the disposal of Krško NPP radioactive waste and spent nuclear fuel

FUND FOR FINANCING THE DECOMMISSIONING OF THE KRŠKO NPP

Head of the projects:

Želimir Veinović, PhD

Project team:

Mario Klanfar, PhD

Vjekoslav Herceg, mag.ing.min., PhD student

Galla Uroić, mag.ing.min, PhD student

Tomislav Korman, PhD

Dubravko Domitrović, PhD

Dalibor Kuhinek, PhD

Marko Cvetković, PhD

Gordana Bilić, PhD

Šime Bilić, PhD

Nikolina Milanović, mag.ing.geol.

Borivoje Pašić, PhD

Dario Perković, PhD

Bojan Matoš, PhD

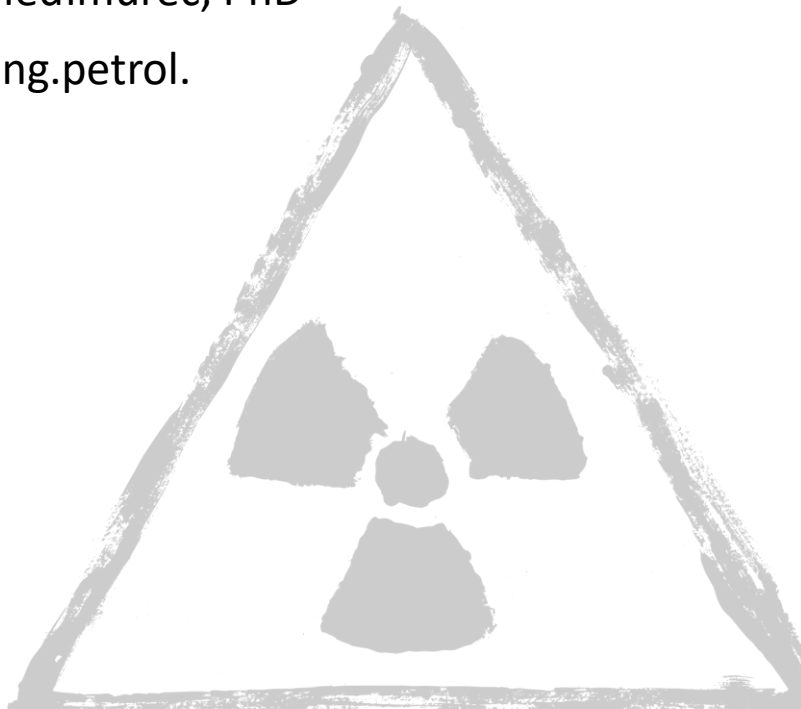
Tomislav Malvić, PhD

Igor Medved, PhD

Petar Mijić, mag.ing.petrol.

Nediljka Gaurina Međimurec, PhD

Bojan Kuhar, mag.ing.petrol.



RGNF

P1 - In-situ simulation of thermo-hydro-mechanical effects on the host rock and buffer material

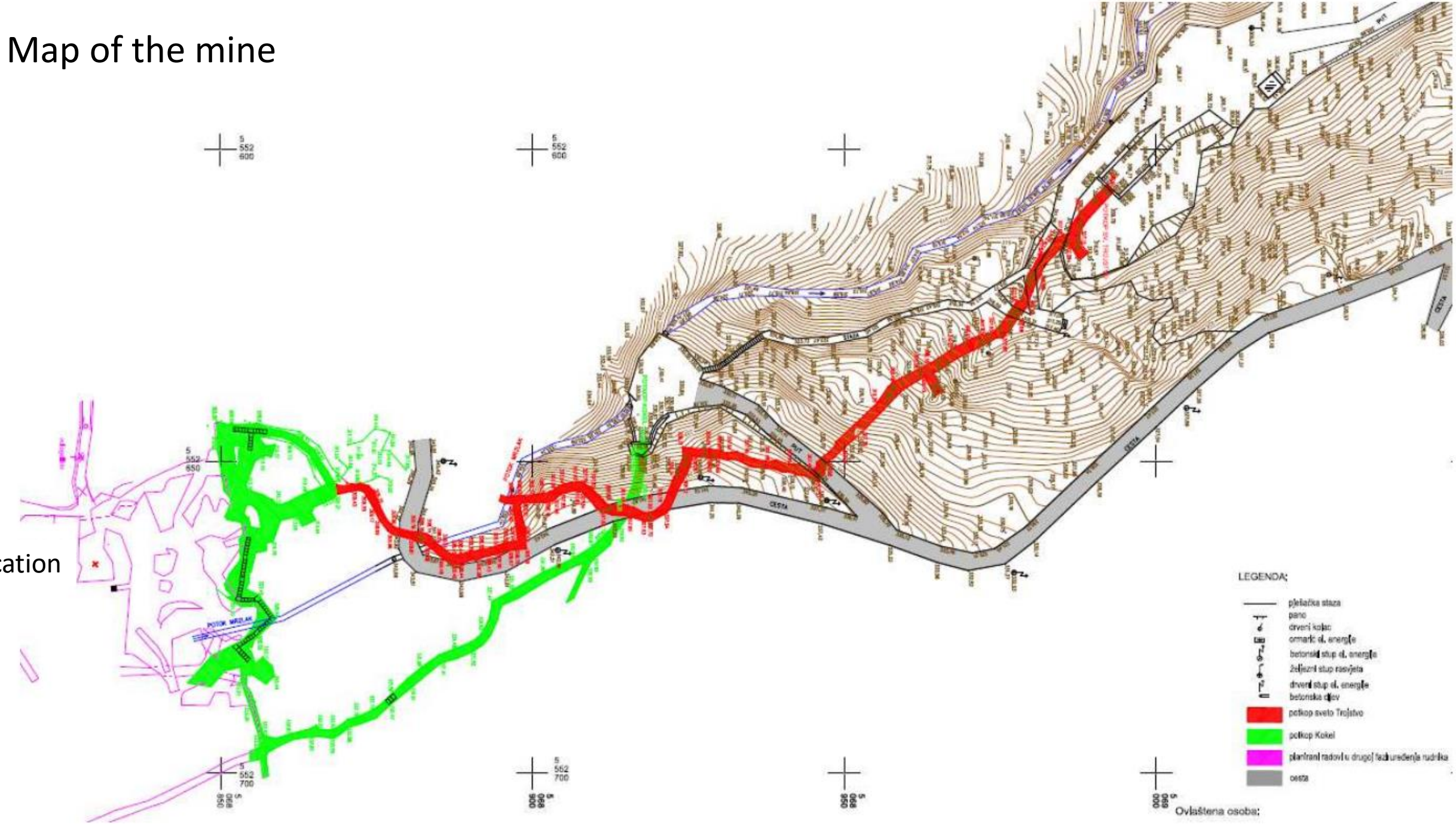
- Initiate research in the field of DGD
- Carry out in-situ experiment to determine THM effects on the host rock
- A lot of laboratory work (soil mechanics, rock mechanics, chemistry, mineralogy, petrology…)
- Verification of results by numerical analysis

Location

- St. Barbara Mine, Rude
- Closed copper and iron ore mine
- Clastic sedimentary rock

Map of the mine

Location

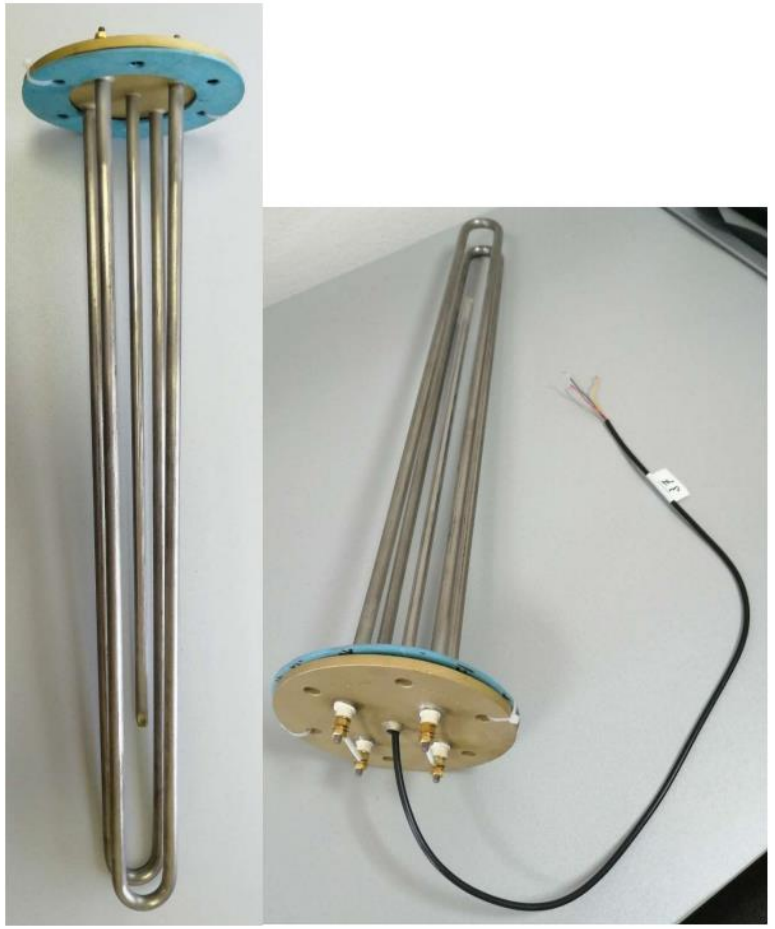


Site preparation

- Tailings removal
- Improving stability of the rock mass (support techniques)
- Handrail installation – easier access to the location of experiment
- Marking points for installation of heating element (canister) and sensors

Canister – heating element

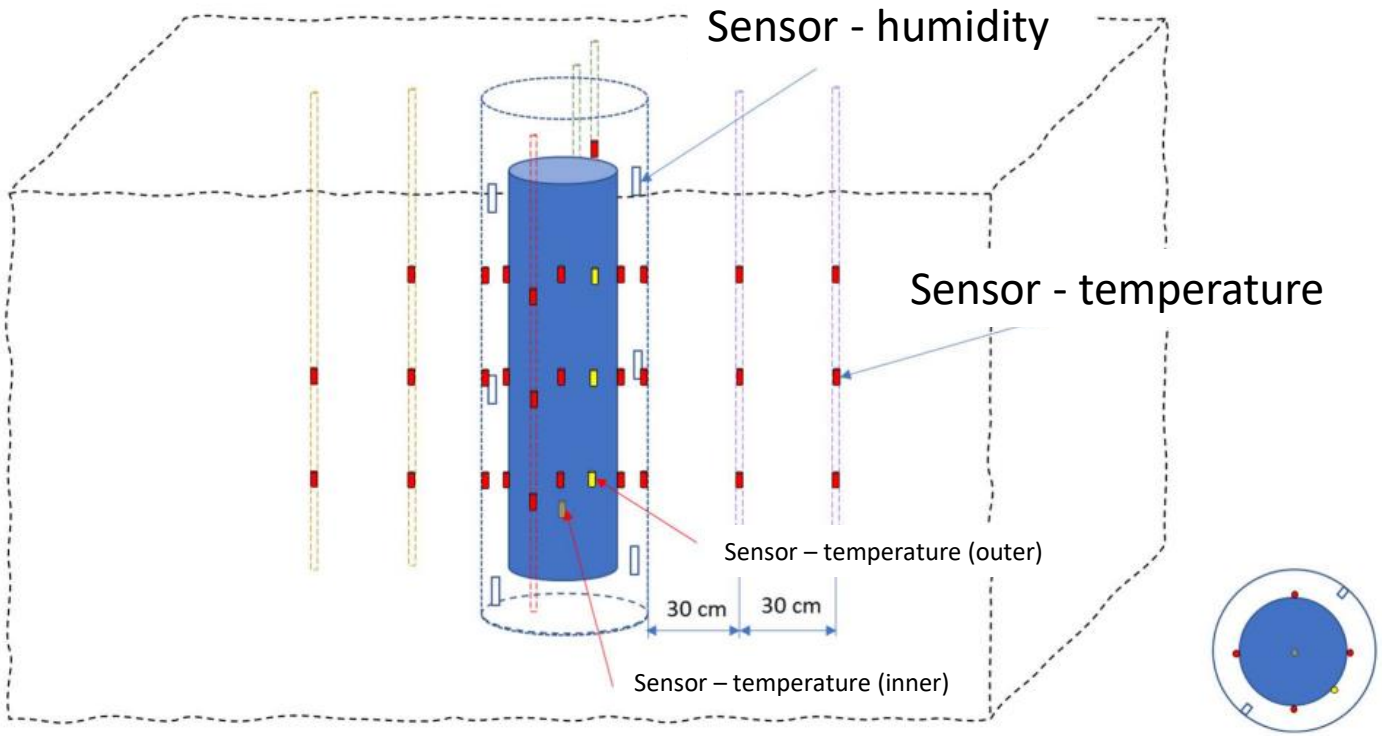
Copper canister



Heating element - before installation in the canister

Canister filling – quartz sand + thermic oil

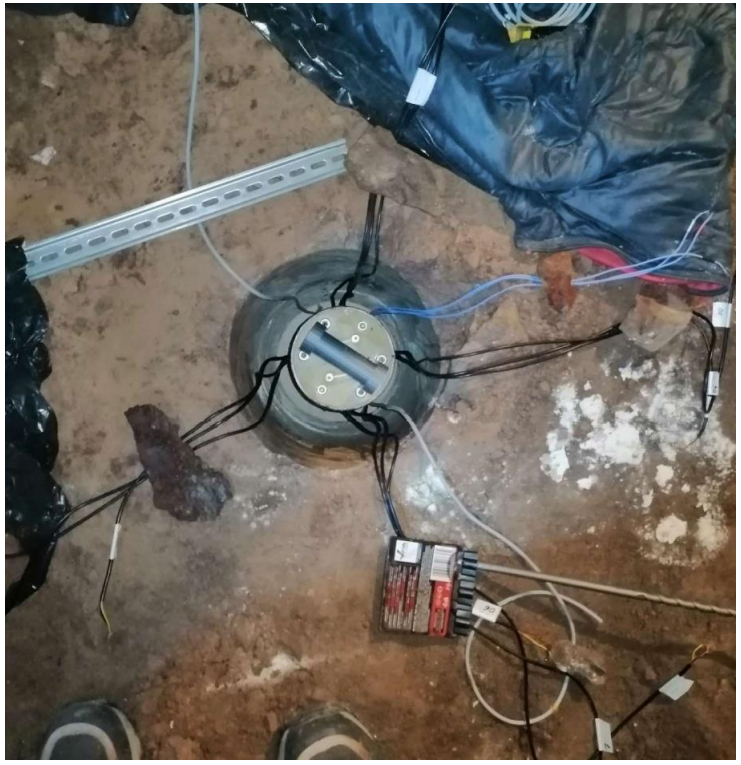
Schematic – heating element in the host rock



Field work…

- Heat transfer through the host rock
- Saturation of the bentonite buffer
- Corrosion of the copper canister
- Determination of microclimate parameters
- Measurement of radon concentration in the mine

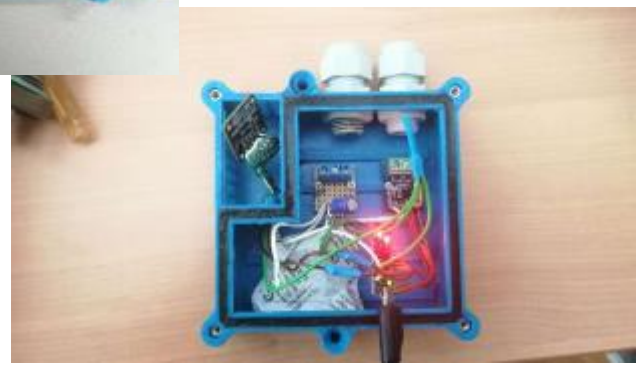
Borehole drilling + installation of the canister



System – installation & trial operation

Determination of microclimate parameters

- Arduino + sensors for detection of temperature and humidity



Measurement of radon concentration

Lab work…

- Copper corrosion
- Changes in the bentonite buffer (soil mechanics)
- Saturation velocity of bentonite clay (SM)
- Determination of the coefficient of linear thermal expansion of the rock (rock mechanics)
- Production of microscopic samples and determination of the mineral composition of the rock
- Determination of the petrological and geochemical composition of the rock
- Other lab work

+ Numerical analysis…

- Verification of the results from the in situ test
- GeoStudio (Sigma/w, Seep/w, Temp/w) + CodeBright

Thank you for ŠČtaying awake!