Henriett Daróczi

Measuring radon and thoron concentration in groundwater sources

Annual progress report
First year 2018/2019
Supervisor: Ákos Horváth

Primary focus

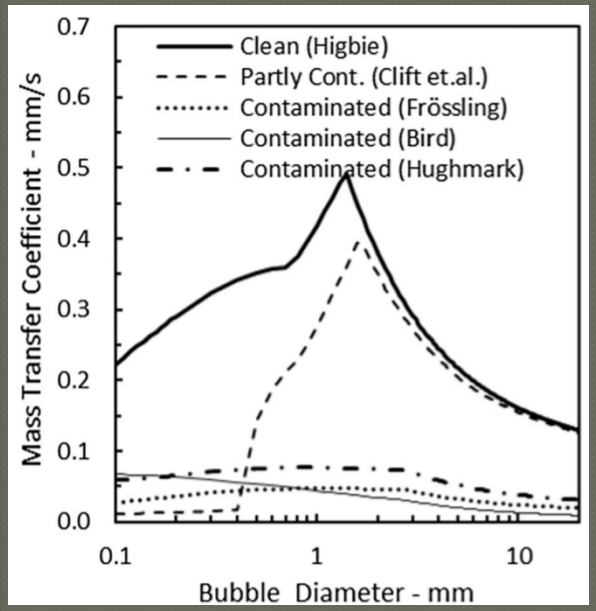
- Measuring the radon and thoron concentrations of the groundwater sources of the Buda Thermal Karst System to better understand
  - its path and velocity in the ground,
  - temporal variability of concentrations,
  - hydrogeological convections,
  - mixture of groundwater and meteoric water,
  - mineral environment that causes anomalous radiation (120 Bq/l – 600 Bq/l).
- Three projects during the first year.

Project I.
Microbubble degassing

Dr. László Sajó-Bohus
Professor emeritus
Simón Bolívar University,
Venezuela

Measurements the lab P22 with
Professor Sajó-Bohus , 25.09.2018.

Project I. Microbubble degassing



Olsen et al. (2017): Mass transfer between bubbles and seawater. *Chemical Engineering Science, Vol. 161*, 308-315.

Olsen et al. (2017)

- Experiments monitoring evolution of size of bubbles in seawater has been conducted.
- Theory on mass transfer is compared to the experimental results.
- Experiments supports a specific correlation for the mass transfer coefficient.

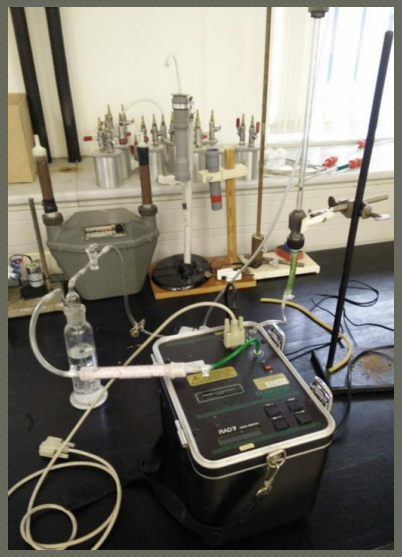
<u>Scientific purpose</u>

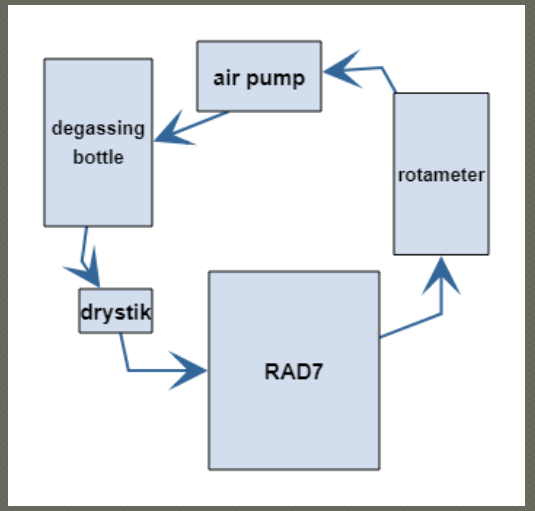
How does the diameter of bubbles affect the degassing process?

Is it similar for radon?

Project I.
Microbubble degassing

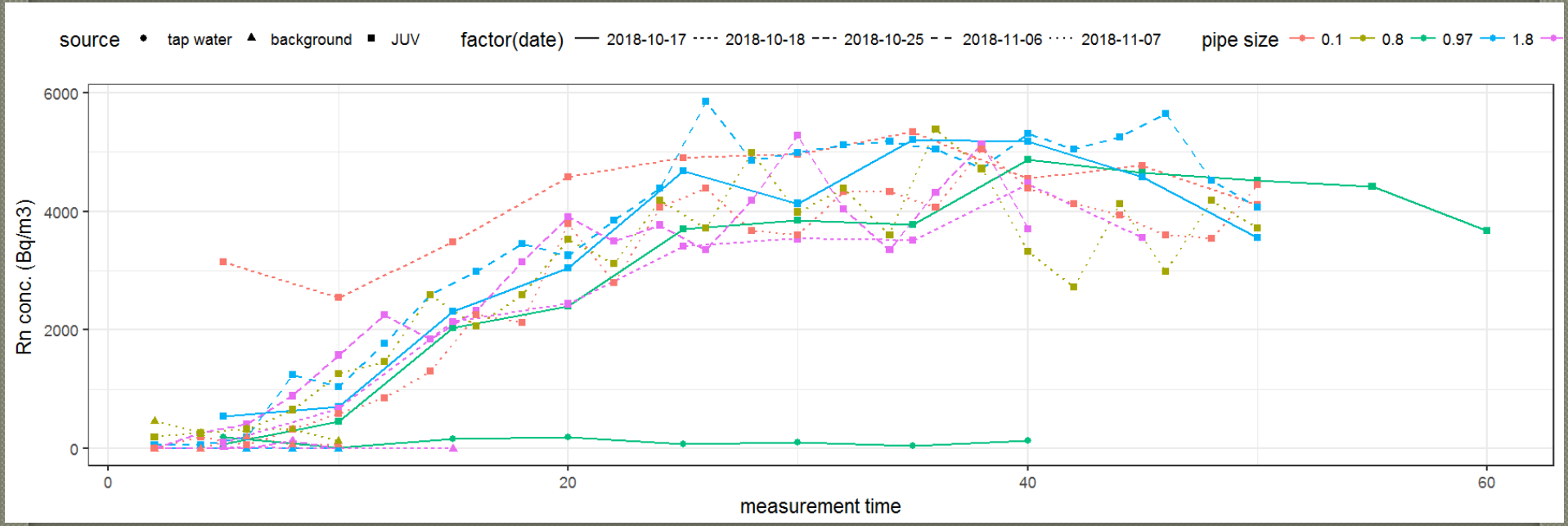
Arrangement of the measurement system





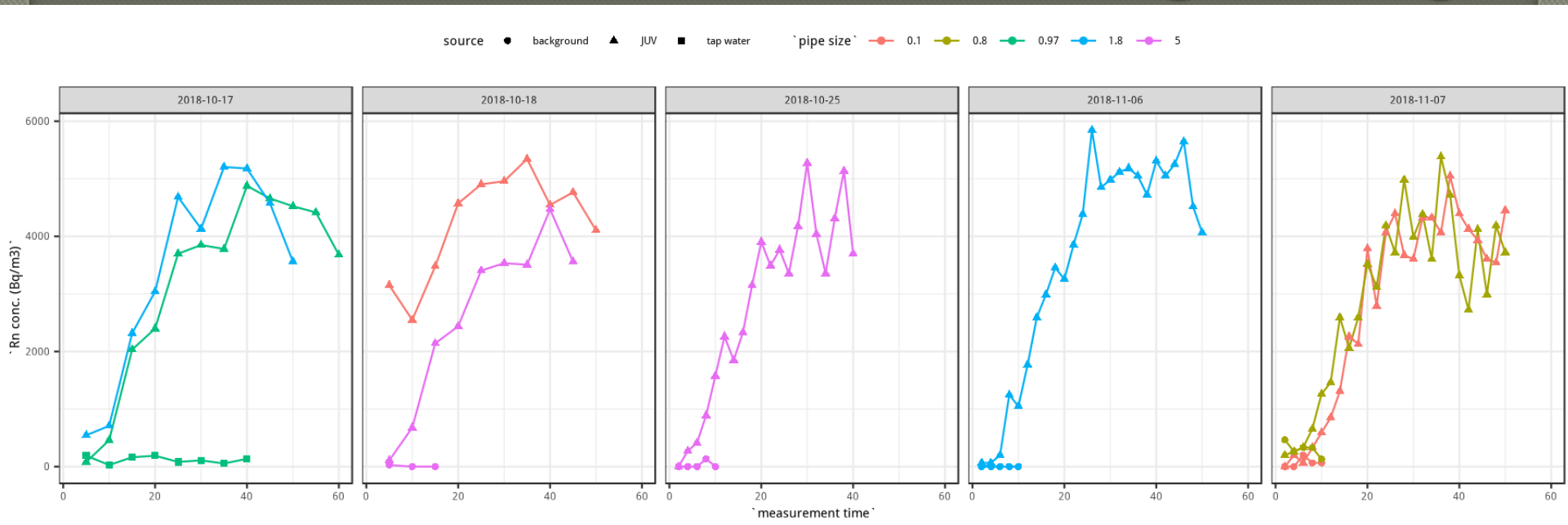
Various caps, diameter size between 0.1 mm -1.8 mm

Project I. Microbubble degassing



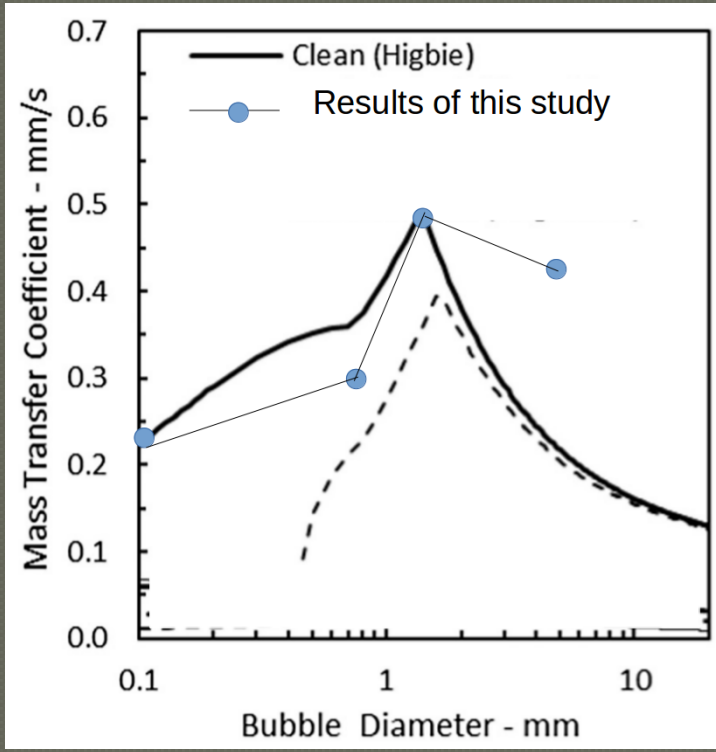
Data visualized with ggplot2 R package

Project I.
Microbubble degassing



Data visualized with ggplot2 R package

Project I. Microbubble degassing



Original graph by Olsen et al. (2017), modified by Sajó-Bohus

Horváth, Á., Daróczi H., Palacios, D., Viloria, T., Sajó-Bohus, L. (2018): Study of the emission of water radon by the bubbling technique. In L*XVIII. Convención Anual AsoVAC La Ciencia en la Venezuela de 2018*. Caracas, Venezuela

Project II.
Drawn spings in Danube

Szenthe István
geologist

In the lab P22

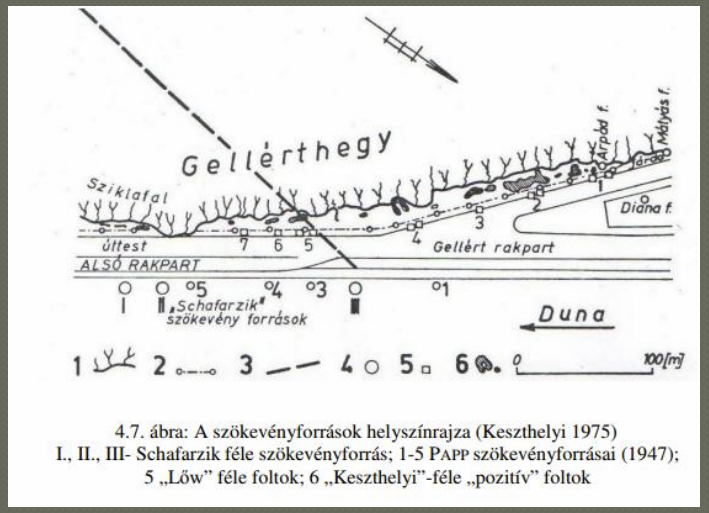
Project II.
Drawn spings in Danube

Rock of Famine in the Danube
15.11.2018

<u>Scientific purpose:</u>

Do the bubbles contain radioactive isotopes?

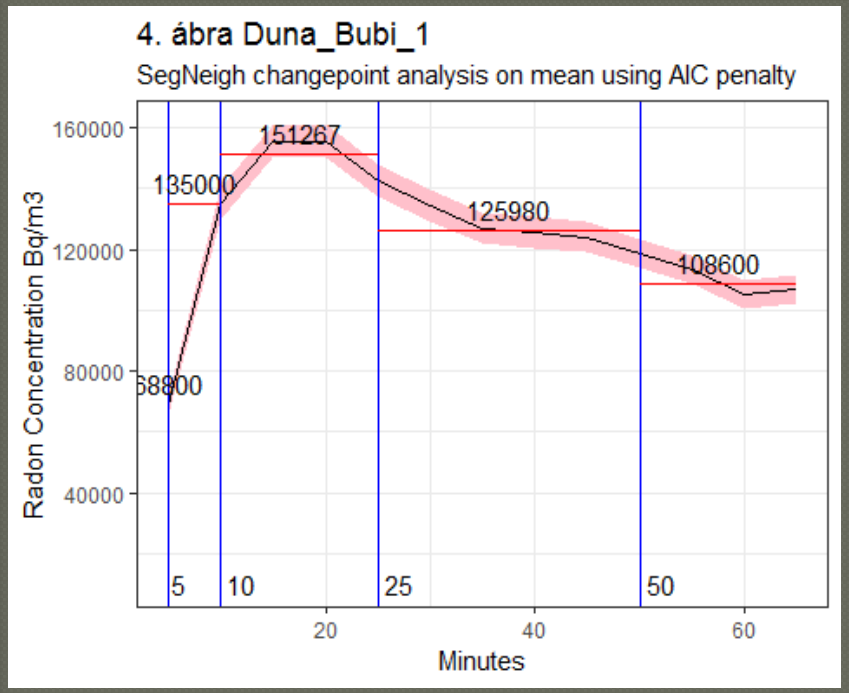
How do they connect to Buda Thermal Karst System?

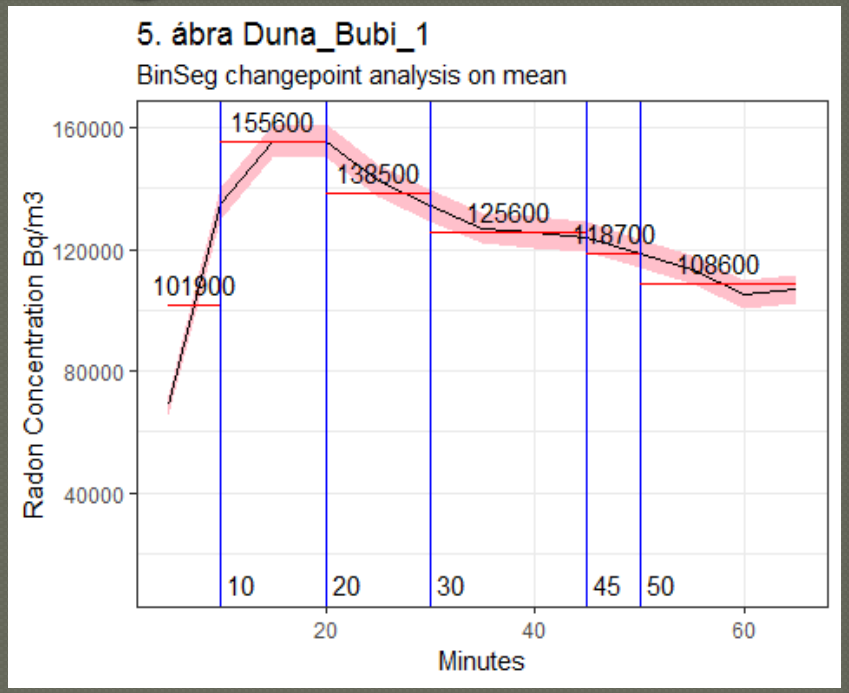


4.7. ábra: A szökevényforrások helyszínrajza (Keszthelyi 1975)
I., II., III- Schafarzik féle szökevényforrás; 1-5 PAPP szökevényforrásai (1947);
5 „Lőw" féle foltok; 6 „Keszthelyi"-féle „pozitív" foltok

Vojnits A. (2008): A radon eredetének és felszín alatti vizek keveredésének vizsgálata a Gellért-hegy közelében. Diplomamunka, ELTE TTK FFI.

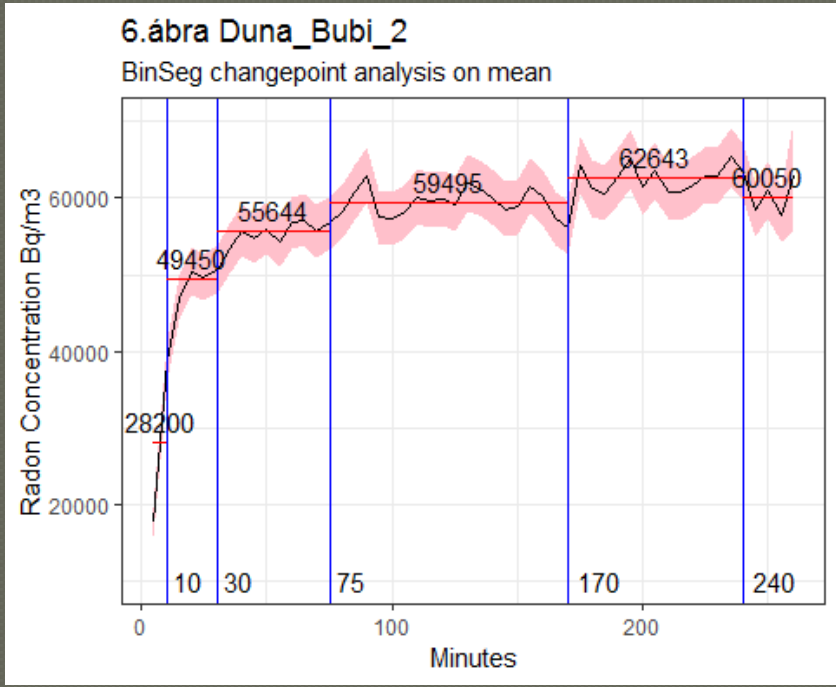
Project II.
Drawn spings in Danube

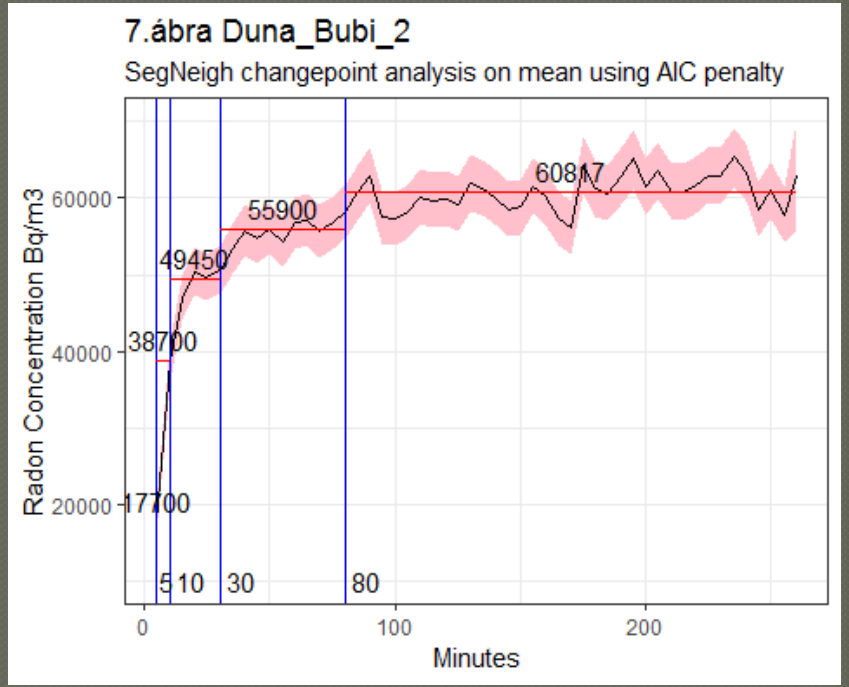




Dataset analysed with changepoint R package
Using BinSeg és SegNeigh methods of cpt.mean function

Project II.
Drawn spings in Danube





Dataset analysed with changepoint R package
Using BinSeg és SegNeigh methods of cpt.mean function

Project III. Thoron device

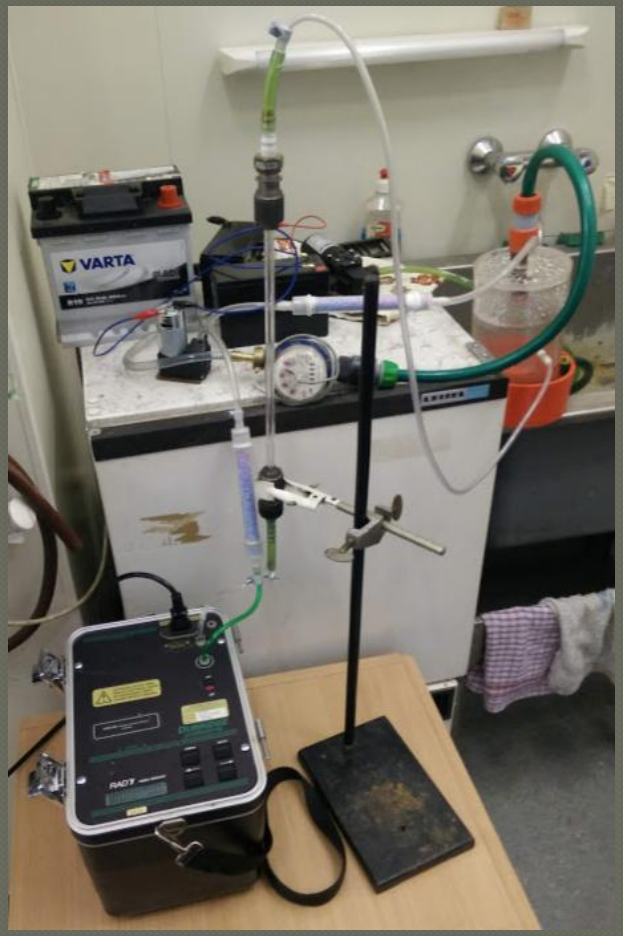
Dr. Henrietta Dulai,
Associate Professor
University of Hawai'i

Swarzenski, P.W. et al., 2017: Observations of nearshore groundwater discharge: Kahekili Beach Park submarine springs, Maui, Hawaii. *Journal of Hydrology: Regional Studies. 11, 147–165.*

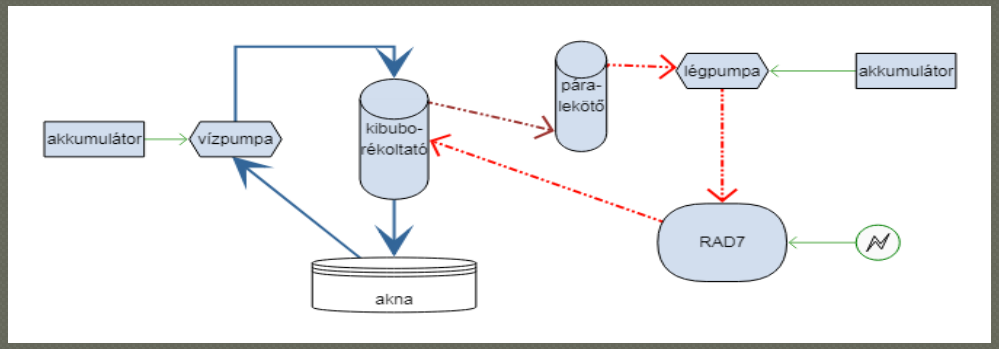
In-situ measurement in Rudas Bath, Diana spring

Project III. Thoron device

- Current status of device



Various sprinklers



Scientific purpose

Making a compact device for in-situ measurement to determine thoron and radon concentration, and to understand the groundwater's path and velocity – the hydrogeological convections

Project III. Thoron device

- Current status of device

JRNC-RANC

2nd International Conference on Radioanalytical and Nuclear Chemistry (RANC 2019)

May 5–10, 2019 / Budapest, Hungary

Measuring the concentration of radioactive isotopes can help us to better understand the path and velocity of groundwater sources.

Measuring radon and thoron concentration in groundwater sources

Henriett Daróczi, Doctoral School of Environmental Sciences, Eötvös Loránd University
Henrietta Dulai, Department of Geology and Geophysics, University of Hawaii
Ákos Horváth, Department of Atomic Physics, Eötvös Loránd University

MOTIVATION

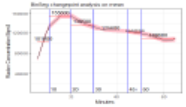
Although we know more and more about the hydrogeological flows of Budai Thermalkarst, but the path and velocity of groundwater sources are still unclear – measuring radon and thoron concentration can give us more insights by understanding the mineral environment causing the explored radioactive anomaly.

MEASUREMENTS

- **Location**: pilot measurements were conducted in the lab, in situ data collection to be scheduled in various springs of Budai Thermalkarst
- **Device**: thermal water was circulated using a *water pump* with at least 3 l/min velocity (controlled by *water flow meter*) in a *3D printed container*, connected to an *air pump* driving radionuclide sample using degassing methods (via *sprinkler/tap aerator*) to feed *RAD7* (*drystick* was used to decrease the humidity, and *air rotameter* monitored the flow rate), as shown in the photos in sidebar.

DATA ANALYSIS METHODS

1. Fitting Gaussian function
2. Fitting polynomial modell
3. Fitting analytical functions
4. Change-point analysis:

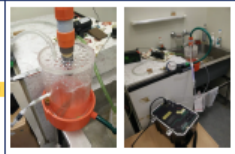


RESULTS

Although the research is still in the early stages, but we have built a working device for data collection and experimented with analytical methods to evaluate the empirical data.

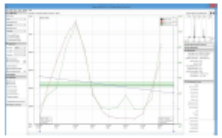
NEXT STEPS

- Improving mobility of the device by making it more compact for in situ measurements.
- Increasing sensitivity and potentially the frequency of measurements.
- More samples to find the most suitable sprinkler types.



REFERENCES

- Csondor K., et al. 2017: Radon as a natural tracer for underwater cave exploration. *Journal of Environmental Radioactivity*. 173. 51-57.
- Dimova, N. et al., 2009: Improved Automated Analysis of Radon (222Rn) and Thoron (220Rn) in *Natural Waters*. Environmental Science & Technology 43, 8599-8603
- Erőss A. et al., 2012: Radionuclides as natural tracers for the characterization of fluids in regional discharge areas, Buda Thermal Karst, Hungary. *Journal of Hydrology*. 124–137.
- Moore, W. S., 2008: Fifteen years in measuring ^{226}Ra and ^{228}Ra by delayed-coincidence counting. *Marine Chemistry*. 109, 188–197.
- Palotai M., Mádné Szőnyi J., Horváth Á (2005): A budapesti Gellért- és József-hegy felszín alatt vízében mért radon- és rádiumtartalom lehetséges forrásai. *Általános Földtan Szemle* 29, 25–40.
- Swarzenski, PW et al., 2017: Observations of nearshore groundwater discharge: Kaheki Beach Park submarine springs, Maui, Hawaii. *Journal of Hydrology: Regional Studies*. 11, 147–165.



In situ measurement at Diana -Hygieia Thermal Spring visualized with RAD7 Capture software

Eötvös Loránd Tudományegyetem

Lectures

- Fall semester
  - Modeling sedimentation of trace gases (Nyomgáz ülepedés modellezése), Dr. Róbert Mészáros
  - Radiation Physics Laboratory, REX Radon exhalation
- Spring semester
  - Writing scientific papers in English, Dr. Béla Böddi
  - Environmental Sampling II.

Conference attendences, publications

- CRUNCH Data engineering and analytics conference, 16-18. October 2018. – support from R Ladies Budapest
- IX Congreso Nacional de Física de la Sociedad Venezolana de Física, CF-45 NF-2018; 23 de Nov. 2018
- Horváth, Á. et al. (2018): Study of the emission of water radon by the bubbling technique. In L*XVIII. Convención Anual AsoVAC La Ciencia en la Venezuela de 2018*. Caracas, Venezuela.
- RANC 2019 2nd International Conference on Radioanalytical and Nuclear Chemistry, May 5-10, 2019. – poster presentation

Thank You for Your attention!