

Report of the Bilateral Hungarian Scholarship 2021/2022

Time Period: 12/11/2021-31/08/2022 (10 months)

Host Institution: **ELTE Eötvös Loránd University- Institute of Geography and Earth Sciences**

Host Professor: **Dr. Judit Mádl-Szőnyi**

The research-training entitled “*The practice of confined/unconfined basin-scale groundwater flow model and its applicability to Mexican karst areas*”; aimed to develop and bring back to date new knowledge and skill in the understanding of the hydrogeology of karst systems through the Gravity Driven Regional Groundwater Flow Systems (GDRGFS) theory (Tóth; 1963,1995, 1999) and their associated environmental and societal benefits and risks.

SUMMARY

	Coordinator & Team-work	Time Period	Activity Description	Outcome and Lesson Learned
ACTIVITIES AND ACCOMPLISHMENT				
Laboratory Practices	<i>Dr Mádl-Szőnyi J. Dr Erőss A. Baják P.</i>	04/2022-05/2022	The laboratory practice was conducted in the Müller-Surbeck hydrogeology lab in the Department of Physical Geology (ELTE), it consisted of having an insight on the methods and techniques used to measure the Uranium series (^{234}U , ^{235}U , ^{238}U), Radium (^{226}Ra) and Radon (^{222}Rn) activity concentration. These radionuclides were found to be important in the study of hypogenic karst development due to mixing processes resulting from confined unconfined endmembers conditions. The measurement of ΣU and ^{226}Ra activity concentration consisted on samples pretreatment and alpha spectrometry using Nuclefilm discs.	<i>Introduction and practical training to the usage of radionuclides (ΣU, ^{226}Ra, ^{222}Rn) to characterize the mixing processes and to differentiate the possible development of hypogene speleogenesis. Such methods will be considered in studying karst in Mexico.</i>
Field visits				
<i>Visit of Buda thermal Karst (Gellért spa & Aragonite cave)</i>	<i>Dr Mádl-Szőnyi J Dr Erőss A.</i>	27/04/2022	The objective of this visit was intended to see some of the manifestation of groundwater flow systems within the Buda thermal karst. The geological framework of the area is dominated mainly by carbonates-siliciclastic formations. Groundwater discharged in the Gellert spa shows highly concentrated waters (high TDS) with temperature ranges between 33°C to 47°C; the discharge was attributed mainly to basinal flow due to the absence of mixing component (Erőss et al., 2012). In Gellert water discharge; the presence of ^{222}Rn might be important in comparison to other radionuclides (U, Ra) and this might be related to the reducing conditions of the basinal flow. The Aragonite cave consist of a dry cave with an isometric spherical shape, this cave was developed in the Triassic dolomite and its genesis was attributed to thermal waters dissolution (CO_2 , HS_2).	<i>In situ characterization of the hypogene contribution to speleogenesis. In addition, practical training of groundwater sampling for Radon concentrations measurement was conducted. These radionuclides can be applied in the case of geothermal sources in Mexico to differentiate the mixing processes.</i>
<i>Visit to the Geothermal energy station: PannErgy</i>	<i>Dr Mádl-Szőnyi J Markó A.</i>	02/06/2022	Understanding the importance of groundwater flow systems in heat accumulation and transfer was one among the objectives of visiting the PannErgy geothermal energy station. Alike conventional sources of energy, geothermal energy is considered to be an advantageous and a renewable type which can meet the needs of population and industry as a sustainable alternate. During the station visit, explanations were given regarding the processes of groundwater energy extraction and reinjection, which needs to follow specific criteria in order not to affect the pressure head and the water table levels as well as the chemical properties of waters underground. The extracted energy is used mainly for heating and electricity generation.	<i>The use of geothermal energy as an alternative to other existing eco-unfriendly solutions is highly recommended and needs to be promoted especially in countries like Mexico; where high geothermal activity is recorded. Despite its geothermal field production; Mexico has not fully benefited from its energy capacity due to the lack of private investments and limited technologies updates in the field.</i>

<i>Fieldtrip to Danube-Tisza Interfluve (Kecskemét Region)</i>	<i>Dr Mádl-Szőnyi J., Dr Simon S., Szijártó M.</i>	07/06/2022-10/06/2022	During the fieldtrip different activities were conducted with undergraduate and postgraduate students, these included, groundwater and soil sampling procedures, and geophysical methods application. During the field trip, we visited the Managed Aquifer Recharge (MAR) area in the Kerekegyháza, which aims to sustain and rehabilitate water levels and ecosystem decline. The project has proved the usefulness of the MAR method for water-table refreshment and lake discharge.	<i>During this field trip, I had the opportunity to learn geophysical techniques as well as to share my experience with undergraduate and postgraduate students. It was a great experience to take part in exchanging knowledge and learning the importance of MAR to preserving ecosystems and biodiversity.</i>
Thesis Review	<i>Participation as a referee for a Master's sciences thesis in Environmental Science program at Eötvös Loránd University. Thesis title: Temporal variability of groundwater conditions in the wetlands of South Nyírség region. Author: Juan Lartey</i>			
Lecture Attendance & Presentation	<i>Dr Ouyse Samira</i>	01/11/2021 21/01/2022	Presentation of the Chiapas project proposal during the meeting led by FAUNAM via ZOOM	
	<i>Dr Mádl-Szőnyi Judit</i>	13/05/2022	Invitation to habilitation presentation where an extensive explanation of the groundwater flow systems was presented through multiples research outcomes and where a summary of the hydrogeology of the Duna Tisza interfluve was given.	
	<i>Dr Márk Szijártó</i>	11/05/2022	The lecture concerns the geophysical methods and their application in the field of hydrogeology; theoretical concepts and practical techniques have been developed and demonstrated during this session.	
Material studied, research analyses Scientific discussion	<i>Prof Mádl-Szőnyi J., Dr Eröss A., Dr Tóth Á., Dr Szijarto M., Dr Havril T, Dr Czauner B., Bajak P.</i>	01/2022-08/2022	Discussion of the research findings and their implications with researchers at the department of Geology were conducted following a planned meeting schedule; this has consisted on an hour discussion with each author of the basic information, methods, and results derived from the published papers. A number of recommendations and specific critical points in this review has been highlighted. The Scientific papers that were subject to analyses and discussions are as follow:	<i>Scientific papers list. Bajak et al. (2022a); Baják et al. (2022b); Eröss et al. (2020); Eröss et al. (2012); Mádl-Szőnyi et al. (2017); Mádl-Szőnyi & Tóth (2015); Tóth et al. (2020); Szijártó et al. (2019); Szijártó et al. (2021); Czauner et al. (2022); Havril et al. (2016)</i>

OUTCOMES & FUTURE PLANS

- a) *Introduction and comprehension of radionuclides measurements, sampling methods and their applicability to confined/unconfined groundwater flow conditions in Karst (Characterization of the possible origin of speleogenesis).*
- b) *Understanding of the karst numerical modelling approaches (Equivalent Porous Media (EPM)), applicability and limitations.*
- c) *Introduction to boundary conditions of groundwater flow and heat transport numerical simulation Using COMSOL.*
- d) *Understanding of the applicability of GDRGFS concept in thick carbonates based on geochemical characterization and numerical and heat transport simulation.*
- e) *Understanding of the importance of installation of Managed Aquifer Recharge (MAR) in aquifers with good hydraulic conductivity, for water replenishment and wetlands rehabilitation.*
- f) *Introduction to the significant role of geothermal energy (heat transfer) as a substitute and Eco-friendly solution which needs to be studied within the framework of GDRGFS concept.*
- g) *Applicability of lessons learned to Mexican karst areas in the future project concerning the transboundary aquifers of Mexicali Valley and Bacalar and Chetumal-Río Hondo.*
- h) *Foster and update the understanding of karst speleogenesis evolution based on the GDRGFS paradigm.*
- i) *Give lectures about the acquired knowledge to postgraduate students and academics of the Institute of Geography, UNAM, Mexico.*

LIMITATIONS & CONDITIONS

1. Delay to get the required support from the contracted service provider to find a rental place previous and during the first weeks of my arrival in Budapest (11/11/2021). Consequently, it took almost one month to stabilize my residence and bank account situation which has affected my academic activities, and this situation coincided with the semester ending.
2. Covid restrictions has limited the academic activities and events especially at the beginning of the study period; thus, most meetings and work were done remotely via Teams.
3. Project cancellation
La Selva Lacandon-Chiapas (Mexico) startup project which was the subject of the research visit has not been approved by CONACYT. From 11/2021 to 02/2022, meetings and project development presentations were conducted with FAUNAM; the main sponsor of the Chiapas project, and due to the lack of additional sponsorship and funds, the project was cancelled.