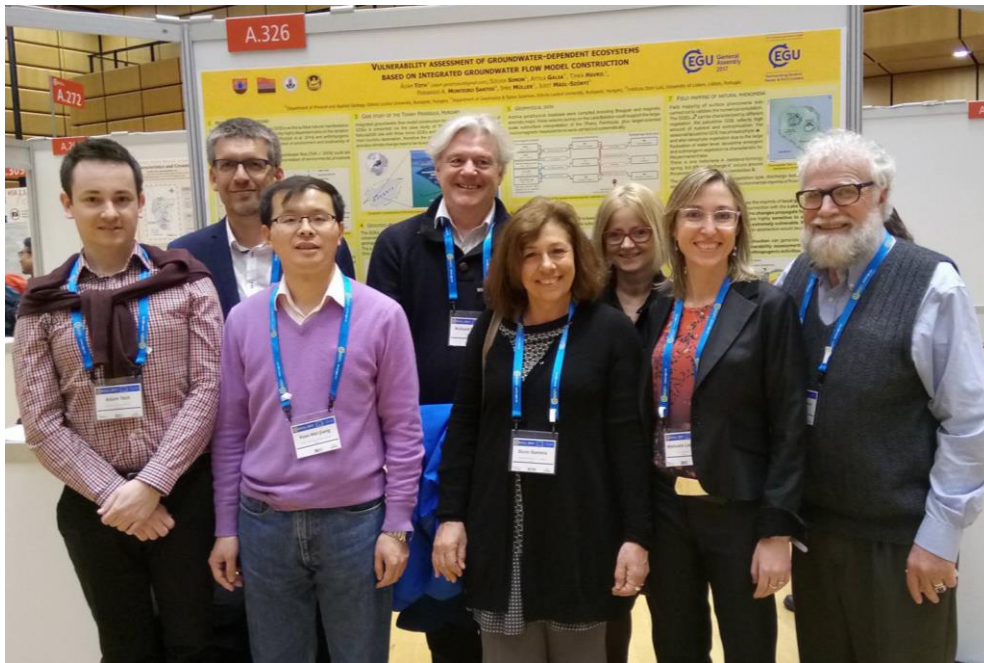




REGIONAL GROUNDWATER FLOW COMMISSION ANNUAL PROGRESS REPORT (July 2016 – April 2017)

1. Sessions at Conferences

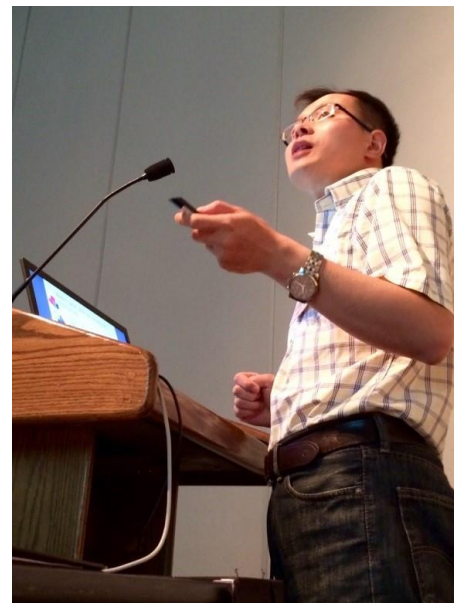
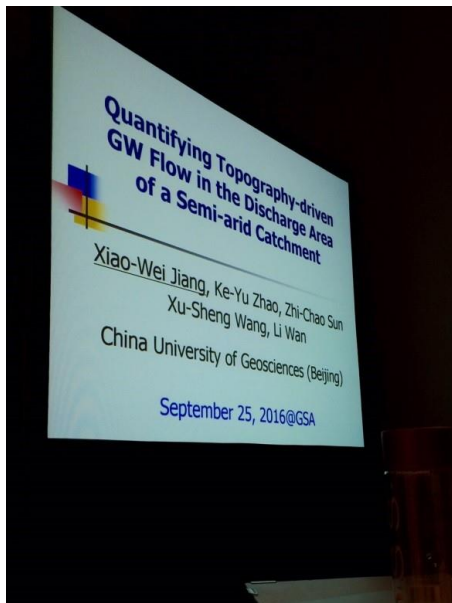
The RGF Commission co-organized a joint session at the EGU General Assembly, 23–28 April 2017, Vienna, entitled *Groundwater vulnerability and circulation* (HS8.2.4) with 6 oral presentations and 18 posters. Chair Jim LaMoreaux and co-chairs Manuela Lasagna, Daniela Ducci, Judit Mádl-Szőnyi and Xiao-Wei Jiang coordinated the session highlighting the role of regional groundwater flow in vulnerability assessment and also social and economic aspects. Papers were invited to bring together scientists studying different aspects related to vulnerability and groundwater circulation.



RGFC Secretary *Ádám Tóth*, Co-Chairs *Okke Batelaan* and *Xiao-wei Jiang*, *Richard Martel*, Session Co-Conveners *Daniela Ducci*, *Judit Mádl-Szőnyi* (RGFC Chair) and *Manuela Lasagna*, Session Convenor *Jim LaMoreaux*

The Commission co-sponsored a session at the Geological Association of America (GSA) Annual Meeting in Denver, Colorado (25 to 28 September 2016). The session was entitled *Approaches to characterizing groundwater flow systems at the watershed-scale for water management and regulation* and attracted 13 oral presentations and 13 posters. The session was very well attended (40 to 90 people during the oral presentations) and included presentations from RGFC's own *Brian Smerdon* (session co-chair) and *Xiao-Wei Jiang*. Many of the presentations focused on achieving a

balance between measurements at discrete points and using these to provide insight to large regions. The session included a broad range of techniques such as classical hydraulic analysis (hydraulic heads and water levels), use of environmental tracers, and numerical modelling. Beyond our session, the regional groundwater flow concept was observed in several other sessions, including *Quantifying Groundwater/Surface Water Interactions in the Field and on the Computer*, *Can't Take the Heat? Temperature as an Indicator and Tracer of Environmental Change*, and *From Pores to Mountains, and Minutes to Millennia: Session Dedicated to the Contributions of Rob Bowman, Fred Phillips, and John Wilson*.



Presentation of Xiao-Wei Jiang at the GSA Meeting 2016, Denver

The Commission organized sessions at the IAHR Congress in celebration of IAHR's 60th anniversary entitled *Verification of conceptual patterns and expected natural effects of regional groundwater flow by interpretation of relevant field observations*.



Chairs Ádám Tóth, Judit Mádl-Szőnyi, René Lefebvre, and John Molson

The session's objective was to encourage comparisons between theoretical predictions of flow patterns and their natural effects in a given study area, on one hand, and measurable parameters of their real-life flow-fields and empirically observed manifestations of interaction between moving groundwater and its environment in the same area, on the other. The two oral sessions and one e-poster session covered the topics of fault zone hydrogeology, petroleum hydrogeology, ecohydrogeology, numerical simulation of groundwater flow and basin hydrodynamics, especially the linkage of observed manifestations of flowing groundwater and modelling of subsurface processes.

2. Training workshops, short courses

Prof. Carrillo-Rivera had an academic visit 24-31 March 2017 in Budapest supported and financed by the Hungarian Ministry of Foreign Affairs and Trade. He had a talk on Groundwater law proposal for Mexico at the Directorate of Water Management of Hungary. In the frame of József & Erzsébet Tóth Endowed Hydrogeology Chair, Prof. Carrillo-Rivera gave a short course entitled Groundwater flow systems and vertical flow, which was attended by master and PhD students of the Eötvös Loránd University.



Attendees of the short course at the Eötvös Loránd University

- Xiaowei Jiang: The theory and applications of basin-scale groundwater circulation – 18 November 2016, Tianjin Center of Geological Survey, China Geological Survey
- Mihael Brenčič (University of Ljubljana): Karst hydrogeology – 23-25 November 2016, Eötvös Loránd University, Budapest
- Vincent Post (Federal Institute for Geosciences and Natural Resources, Hannover, Germany): The use of chemical and isotope tracers to study the coastal groundwater system in the greater Adelaide region, South Australia –1 December 2016, Eötvös Loránd University, Budapest

- Xiaowei Jiang: The theory and applications of basin-scale groundwater circulation – 4 January 2017, Institute of Geographic Sciences and Natural Resources, Chinese Academy of Sciences
- Xiaowei Jiang: The theory and applications of basin-scale groundwater circulation – 13 April 2017, Hebei University of Geosciences
- Xiaowei Jiang: The theory and applications of basin-scale groundwater circulation – 13 April 2017, Institute of Hydrogeology and Environmental Geology, Chinese Geological Academy of Sciences
- Sun Ronglin (China University of Geosciences): The theory of groundwater flow system and its application in hydrogeological investigation – 18 April 18 2016, Xingshan, Yichang, China
- Liang Xing (China University of Geosciences): The theory of groundwater flow system and its application in 1:50000 hydrogeological mapping – 17-18 April 2017, Xingshan, Yichang, China
- Carrillo-Rivera JJ: Vertical flow and early alert in low hydraulic conductivity media: the fracking case – 26 April 2017, Agricultural Institute of Investigation and Higher Teaching, INAT, Tunis, Tunisia
- Carrillo-Rivera JJ: Is seawater intrusion in an arid coastal aquifer developed for agriculture, important? An Example from Santo Domingo, Baja California – 26 April 2017, Agricultural Institute of Investigation and Higher Teaching, INAT, Tunis, Tunisia

3. Dissemination of Knowledge

The RGFC celebrated IAH's 60th anniversary in the form of *Student Competition on Regional Groundwater Flow* in collaboration with the ECHN, IAH Executive and organizers of the 43rd IAH Congress. After the first, online, round nine university teams qualified for the second round held in Montpellier, where different regional groundwater flow topics were presented by each of them. Teams of the second round:

Hydro Puff Girls, University of Miskolc, Miskolc, Hungary

Rotomagus, University of Rouen, Rouen, France

ITB Hydrogeology, Institut Teknologi Bandung, Bandung, Indonesia

Looking at the Basin!, China University of Geosciences, Beijing, China

ENSEGID, Ecole Nationale Supérieure en Environnement, Géoressources et

Ingénierie du Développement durable, Bordeaux, France

UofA Hydro, University of Alberta, Edmonton, Canada

Flow-ers, Eötvös Loránd University, Budapest, Hungary

INOWAS, TU Dresden, Dresden, Germany

The Hydraulic Heads, University Laval, Québec, Canada



Contestants, judges and organizers of the Student Competition on Regional Groundwater Flow with former president of IAH, Ken Howard

The judges during the presentations:

Judit Mádl-Szőnyi, Chair of RGFC, Eötvös Loránd University, Hungary
Joanne Thompson, R.J. Burnside & Associates Limited, Newmarket, Canada
John Molson, Laval University, Canada
René Lefebvre, INRS, Canada
José Joel Carrillo Rivera, UNAM, Mexico
Carlos Molano, University of Los Andes, Colombia
Carlos Maldener, Chair of ECHN, University of Guelph, Canada
Alexis Gutierrez, BRGM, France.

We would like to congratulate all of the teams for their efforts to learn more about regional groundwater flow. Four teams excelled during the event:

3rd prize for INOWAS (Jana Sallwey, Jana Ringleb), Germany and
3rd prize for Flow-ers (Katalin Csondor, Virág Török), Hungary,
2nd prize for The Hydraulic Heads (Débora János, Marc Laurencelle), Canada
1st prize for UofA Hydro (Judit Déri-Takács, Daniel Skoreyko), Canada.

Congratulations to the awardees!

The prizes are one-year memberships for 2017 provided by IAH, additional small prizes granted by IAH–RGFC and regional groundwater flow related books.



The initiators and awardees of the Student Competition on Regional Groundwater Flow: Ádám Tóth, Virág Török and Katalin Csondor (Flow-ers), António Chambel, Judit Mádl-Szőnyi, Judit Déri-Takács and Daniel Skoreyko (UofA Hydro), Debora János and Marc Laurencelle (The Hydraulic Heads)

The Council of IAH, appointed by election by the full membership every four years, is the Association's governing body. Our current Council was elected at the General Assembly in Montpellier, France in September 2016. Two of our active RGFC representatives are now members of the IAH Council: Joanne Thompson – Vice President, North America and Carlos Molano – Vice President, Latin America and the Caribbean.

The Commission is pleased to announce that Professor József Tóth, the Lifetime Honorary Chair of RGFC, has been elected as a member of the Hungarian Academy of Sciences. His lecture *Theory of the Tóthian groundwater flow and its consequences from 1963 to nowadays* demonstrated the two ramifications of the umbrella theory, namely the basin-scale hydraulics and groundwater as geologic agent. IAH joins the Commission in offering congratulations to him!

József and Erzsébet Tóth Endowed Hydrogeology Chair was funded on 1 September 2016 at Faculty of Science, Eötvös Loránd University, Budapest thanks to generous donation of Prof. József Tóth. The main scope of the Chair is teaching, fostering, promotion and application of the „Tóthian” modern hydrogeological approach. The elaboration and preservation of the famous library of Tóth was also integrated into the activity of the Chair. The head is Judit Mádl-Szőnyi (Chair of RGFC) and she cooperates with her colleagues, PhD and MSc students in the frame of this group to urge the recognition of the vital Tóthian scientific heritage. The chair would like to attract scientific interest worldwide.

RGFC launched its LinkedIn page, which is a forum for scientific discussion, in autumn of 2014 and since then the number of members reached 249 (~60 new members during this report period).

4. Stand-alone Specialist Symposium

International Symposium Characterizing Regional Groundwater Flow Systems: Insight from practical applications and theoretical development (26-28 June 2017, Calgary, Canada) will examine the current state of the regional groundwater flow concept, discuss any recent theoretical advancement, and share experiences from applications spanning energy exploration to environmental management. The symposium has accepted 48 oral presentations and 22 poster presentations under the following session themes:

- Groundwater Flow Fundamentals
- Near Surface Processes
- Site Characterization
- Geochemistry & Numerical Simulation
- Economic Reserves
- Oil Sands
- Geochemical Characterization
- Water Management & Numerical Simulation

This symposium will also have two optional 1-day field excursions in southern Alberta to learn more about the history of Canadian hydrogeology and hydrocarbon exploration.

The symposium will be hosted by the IAH Canadian National Chapter, and organized by the IAH Commission on Regional Groundwater Flow in cooperation with the IAH Commission on Groundwater and Energy.

5. Commission Review by David Kreamer

The Commission received the following letter by the new IAH Vice President for Science and Programme, David Kreamer. He acknowledged the activity of the RGFC and also the scientific value of our publications and hoped to continue this work in the future.

“As a new fellow at this job, I reviewed your 2012- 2015 CRGF Annual Reports which are posted on the IAH website, and have read and greatly admired many of your publications in the past. I also saw your independent CRGF-IAH website link to the main IAH website, which is really very good and well illustrated. It is a really great website and quite informative. ... your work and efforts have been world class for many

years – thanks! I've had the pleasure of reading some of your individual publications on groundwater flow, and know that your individual work is outstanding. I'm aware that you have put much effort into integrating many groups working together on similar issues, and I'm particularly pleased to see all of your educational and outreach efforts, and your upcoming conference this June in Calgary. You and your colleagues have put significant energy into this Commission and I would like to offer my assistance in any way to ensure that you keep going strong, are reaching other scientists and decision makers, and advancing your fundamental objectives."

6. Publications

Papers and books

Custodio E, Albiac J, Cermerón M, Hernández M, Llamas MR, Sahuquillo A 2017: Groundwater mining: benefits, problems and consequences in Spain. Sustainable Water Resources Management. DOI 10.1007/s40899-017-0099-2

Jódar J, Cabrera JA, Martos-Rosillo S, Ruiz-Constán A, González-Ramón A, Lambán LJ, Herrera C, Custodio E 2017: Groundwater discharge in high-mountain watersheds: A valuable resource for downstream semi-arid zones. The case of the Bérchules River in Sierra Nevada (Southern Spain). Science of the total Environment 593-594, pp. 760-772.

Battle-Aguilar J, Banks EW, Batelaan O, Kipfer R, Brennwald MS, Cook PG 2017: Groundwater residence time and aquifer recharge in multilayered, semi-confined and faulted aquifer systems using environmental tracers. Journal of Hydrology 546: 150-165. <http://dx.doi.org/10.1016/j.jhydrol.2016.12.036>

Jiang XW, Sun ZC, Zhao KY, Shi FS, Wan L, Wang XS, Shi ZM 2017: A method for simultaneous estimation of groundwater evapotranspiration and inflow rates in the discharge area using seasonal water table fluctuations. Journal of Hydrology 548, pp. 498-507, DOI: 10.1016/j.jhydrol.2017.03.026.

Zhao KY, Jiang XW, Wang XS, Wan L, Wang JZ, Wang H, Li HL 2016: An Analytical Study on Nested Flow Systems in a Tóthian Basin with a Periodically Changing Water Table. Journal of Hydrology. DOI: 10.1016/j.jhydrol.2016.09.051.

Erhardt I, Ötvös V, Erőss A, Czauner B, Simon Sz, Mádl-Szőnyi J 2017: Hydraulic evaluation of the hypogenic karst area in Budapest (Hungary). Hydrogeology Journal. DOI 10.1007/s10040-017-1591-3

Mádl-Szőnyi J, Tóth Á 2017: Topographically Driven Fluid Flow at the Boundary of Confined and Unconfined Sub-basins of Carbonates: Basic Pattern and Evaluation Approach on the Example of Buda Thermal Karst. – In: Renard P, Bertrand C (eds) EuroKarst 2016, Neuchâtel: Advances in the Hydrogeology of Karst and Carbonate Reservoirs. Springer International Publishing, pp. 89-98.

Makk J, Tóth E, Anda D, Pál S, Schumann P, Kovács AL, Mádl-Szőnyi J, Márialigeti K, Borsodi AK 2017: *Deinococcus budaensis* sp. nov., a mesophilic species isolated from biofilm sample of a hydrothermal spring cave. *International Journal of Systematic and Evolutionary Microbiology* 66: pp. 5345-5351

Iván V, Mádl-Szőnyi J 2017: State of the art of karst vulnerability assessment: overview, evaluation and outlook. *Environmental Earth Sciences* 76:(3). doi:10.1007/s12665-017-6422-2

Singh A, Palombi D, Nakevska N, Jensen G, Rostron B 2017: An efficient approach for characterizing basin-scale hydrodynamics. *Marine and Petroleum Geology* 84: pp. 332-340.

Havril T, Molson JW, Mádl-Szőnyi J 2016: Evolution of fluid flow and heat distribution over geological time scales at the margin of unconfined and confined carbonate sequences - A numerical investigation based on the Buda Thermal Karst analogue. *Marine and Petroleum Geology* 78: pp. 738-749.

Csondor K, Erőss A, Horváth Á, Szieberth D 2016: Radon as a natural tracer for underwater cave exploration. *Journal of Environmental Radioactivity* 173: pp. 51-57.

Tóth J 2016: The Evolutionary Concepts and Practical Utilization of the Tóthian Theory of Regional Groundwater Flow. *International Journal of Earth and Environmental Sciences* 1:111

Tóth J 2016: A short story of the theory of gravity-driven basin-scale groundwater flow and its consequences. In: Bogomolov YG (ed) *Oldest Hydrogeologists of the World – Scientific and popular memories*, pp. 436-463. *Belaruskaya navuka*, Minsk

El-Rawy M, De Smedt F, Batelaan O, Schneidewind U, Huysmans M, Zijl W 2016: Hydrodynamics of porous formations: Simple indices for calibration and identification of spatio-temporal scales. *Marine and Petroleum Geology* 78: 690-700. <http://dx.doi.org/10.1016/j.marpetgeo.2016.08.018>

Bresciani E, Goderniaux P, Batelaan O 2016: Hydrogeological controls of water table-land surface interactions. *Geophysical Research Letters* 43(18): pp. 9653-9661.

Bresciani E, Gleeson T, Goderniaux P, de Dreuzy JR, Werner AD, Wörman A, Zijl W, Batelaan O 2016: Groundwater flow systems theory: research challenges beyond the specified-head top boundary condition. *Hydrogeology Journal* 24(5): pp. 1087-1090.

Tam VT, Batelaan O, Beyen I 2016: Impact assessment of climate change on a coastal groundwater system, Central Vietnam. *Environmental Earth Sciences* 75(10):908.

Ouyse S, Carrillo-Rivera JJ, Hernández-Carcia GJ, Ramirez-Beltrán M 2016: Groundwater sources in semi-arid regions and their vulnerability to climate change: Drâa Catchment, Morocco – In: *Geostatistical and Geospatial Approaches for the Characterization of Natural Resources in the Environment, Challenges, Processes and Strategies, Part II*, Raju, N. Janardhana (Ed.), Springer International Publishing, pp. 237-243.

Huizar-Alvarez R, Ouyse S, Espinoza MM, Carrillo-Rivera JJ, Mendoza-Archundia E 2016: The effects of water use on Tothian flow systems in the Mexico City conurbation determined from the geochemical and isotopic characteristics of groundwater. *Environmental Earth Sciences* 75:1060. DOI 10.1007/s12665-016-5843-7

Ferreira do Rosário F, Custodio E, Cardoso da Silva Jr G 2016: Hydrogeology of the Western Amazon Aquifer System (WAAS). *Journal of South American Earth Sciences* 72, pp. 375-386.

Hornero J, Manzano M, Ortega L, Custodio E 2016: Integrating soil water and tracer balances, numerical modelling and GIS tools to estimate regional groundwater recharge: Application to the Alcadozo Aquifer System (SE Spain). *Science of the Total Environment* 568, pp. 415-432.

Herrera C, Custodio E, Chong G, Lambán LJ, Riquelme R, Wilke H, Jódar J, Urrutia J, Urqueta H, Sarmiento A, Gamboa C, Lictevout E 2016: Groundwater flow in a closed basin with a saline shallow lake in a volcanic area: Laguna Tuyajto, northern Chilean Altiplano of the Andes. *Science of the Total Environment* 541, pp.303-318.

Custodio E, Jódar J 2016: Simple solutions for steady-state diffuse recharge evaluation in sloping homogeneous unconfined aquifers by means of atmospheric tracers. *Journal of Hydrology* 540, pp. 287-305.

Custodio E, Andreu-Rodes JM, Aragón R, Estrela T, Ferrer J, García-Aróstegui JL, Manzano M, Rodríguez-Hernández L, Sahuquillo A, del Villar A 2016: Groundwater intensive use and mining in south-eastern peninsular Spain: Hydrological, economic and social aspects. *Science of the Total Environment* 559, pp. 302-316.

Custodio E, Cabrera MC, Poncela R, Puga LO, Skupien E, del Villar A 2016: Groundwater intensive exploitation and mining in Gran Canaria and Tenerife, Canary Islands, Spain: Hydrogeological, environmental, economic and social aspects. *Science of the Total Environment* 557-558, pp. 425-437.

Conference Presentations

Tóth Á, Simon Sz, Galsa A, Havril T, Monteiro Santos FA, Müller I, Mádl-Szőnyi J 2017: Vulnerability assessment of groundwater-dependent ecosystems based on integrated groundwater flow model construction. EGU General Assembly 2017, Vienna, Austria, 24–28 April 2017

Mádl-Szőnyi J, Czauner B, Iván V, Tóth Á, Simon Sz, Eröss A, Havril T, Bodor P 2017: Deep seated carbonates and their vulnerability – are they isolated or hydrodynamically interacted? EGU General Assembly 2017, Vienna, Austria, 24–28 April 2017

Csondor K, Eröss A, Horváth Á, Szieberth D 2016: Radon as a natural tracer for thermal karst aquifers and hypogenic caves. EGU General Assembly 2017, Vienna, Austria, 24–28 April 2017

Nakevska N, Brinsky J, Singh A 2017: Mapping groundwater conditions of deep saline formations in West-Central Alberta. WaterTechnologies Symposium, Banff, Canada, 3–5 April 2017

Smerdon B, Babakhani M, Nakevska N, Mei S, Atkinson L, Andriashek L 2017: Characterizing hydrogeological conditions to a depth of 1 km in west-central Alberta. NGWA Hydrogeophysics and Deep Groundwater, Denver, CO, 20 - 21 March 2017

Cardona BA, Carrillo-Rivera JJ 2017: Vertical flow and early alert in low hydraulic conductivity media. GSA South-Central Section. 13–14 March 2017, San Antonio, Texas, USA

Huizar-Alvarez R, Carrillo-Rivera JJ 2017: The groundwater management unit in Mexico. GSA South-Central Section. 13–14 March 2017, San Antonio, Texas, USA

Anda D, Szabó A, Felföldi T, Bodor P, Makk J, Mádl-Szőnyi J, Márialigeti K, Borsodi A 2016: In situ experiment model system for studying the biofilm development in a hydrothermal spring cave. Annual Meeting of the Hungarian Society for Microbiology, Budapest, Hungary, 19–21 Nov 2016

Enyedi NT, Anda D, Borsodi A, Mádl-Szőnyi J, Márialigeti K, Makk J 2016: Cultivation of radioresistant bacteria from the biofilm developed in the Diana-Hygieia thermal spring. Annual Meeting of the Hungarian Society for Microbiology, Budapest, Hungary, 19–21 Nov 2016

Smerdon B, Gardner WP 2016: Can river water data be leveraged to understand groundwater circulation for a large area? Geological Society of America Abstracts with Programs. Vol. 48, No. 7 doi: 10.1130/abs/2016AM-282756

Tóth Á, Galsa A, Simon Sz, Havril T, Monteiro Santos FA, Müller I, Mádl-Szőnyi J 2016: Groundwater-related environmental phenomena in complex geologic setting of Tihany Peninsula, Hungary. 43rd IAH Congress, Montpellier, France, 25–29 Sept 2016

Mádl-Szőnyi J, Tóth Á, Simon Sz, Galsa A 2016: Comparison of 2D simulated flow pattern and measured hydraulic data for a confined aquifer to reveal the influence of gravity and heat on flow pattern. 43rd IAH Congress, Montpellier, France, 25–29 Sept 2016

Csondor K, Erőss A 2016: Thermal waters in the Villány region (Hungary) – hydraulic and geochemical interplay of karst and sedimentary basin. 43rd IAH Congress, Montpellier, France, 25–29 Sept 2016

Havril T, Molson JW, Mádl-Szőnyi J 2016: Evolution of regional groundwater flow and heat distribution over geological time scale at the margin of unconfined and confined carbonate sequences. 43rd IAH Congress, Montpellier, France, 25–29 Sept 2016

Tóth Á, Mádl-Szőnyi J 2016: Geothermal potential assessment of carbonates based on spring characterization and numerical simulation, example of Transdanubian Range, Hungary. Eurokarst, Neuchâtel, Switzerland, 5–7 Sept 2016

Mádl-Szőnyi J, Tóth Á 2016: Topographically driven fluid flow at the boundary of confined and unconfined sub-basins of carbonates: basic pattern and evaluation

approach on the example of Buda Thermal Karst. Eurokarst, Neuchâtel, Switzerland, 5–7 Sept 2016

Bodor P, Mádl-Szőnyi J 2016: In-situ experimental study of the development of biogeochemical precipitate in the discharge area of thermal waters, Buda Thermal Karst, Hungary. Eurokarst, Neuchâtel, Switzerland, 5–7 Sept 2016

Havril T, Molson JW, Mádl-Szőnyi J 2016: Numerical simulation of fluid flow and heat transport evolution over geological time scales for the Buda Thermal Karst, Hungary. Eurokarst, Neuchâtel, Switzerland, 5–7 Sept 2016

Csondor K, Erőss A 2016: Hydraulic and geochemical characterization of the Villány thermal karst area (Hungary). Eurokarst, Neuchâtel, Switzerland, 5–7 Sept 2016

Erőss A, Csondor K 2016: First results of the hydraulic and geochemical evaluation of the Villány thermal karst area. 12th International Conference on Mineral Waters of the Carpathian Basin. Mohács, Hungary, 31 Aug – 1 Sept 2016

Budapest, 13 May 2017

Ádám Tóth, Secretary of RGFC

Judit Mádl-Szőnyi, Chair of RGFC