# REGIONAL GROUNDWATER FLOW COMMISSION

# ANNUAL PROGRESS REPORT

(May 2017 – December 2017)

## 1. Renewal of the Commission

The initial 6-year-long licence of the RGFC ended in September 2017. The RGFC can continue its activities on the basis of the very positive and supporting opinion of the IAH Council but a renewal procedure of the Commission's Board was needed. For the forthcoming 6-year period, the RGFC would like to have Co-Chairs representing different regions covering the whole world: North America, Latin America, Europe, Africa, Asia, Australia.

The Commission members were informed about the renewal. Nominations were received by 15 September 2017, except for the Co-Chair positions for North America and Africa. Therefore, individual invitation letters were sent to the active representatives from these regions. Finally, there were nominees for all of the positions.

The voting procedure was supervised by David Kreamer (IAH Vice President for Science and Programme) and all members of the RGFC could vote (RGFC members are the subscribers of the newsletter) plus the Council Members and Commission Chairs, as well.

The voting system was provided and activated on 30 November 2017. Voting was possible until 8 December 2017, 12:00 GMT. The voters had up to 8 votes, for a valid vote at least 1 was required. This voting procedure was only used to confirm Co-Chairs as there was only one candidate for each of the positions.

The participation rate was 28 % which means 54 voters. Here are the final results:

- Chair: Judit Mádl-Szőnyi (53 votes)
- Secretary: Ádám Tóth (54 votes)
- Co-Chair for North America: René Lefebvre - John Molson (52 votes)
  The position of North America Co-Chair will be alternated between René Lefebvre and John Molson.
- Co-Chair for Latin America: José Joel Carrillo-Rivera (51 votes)
- Co-Chair for Europe: Hanneke Verweij (51 votes)
- Co-Chair for Africa: Fadoua Hamzaoui Azaza (49 votes)
- Co-Chair for Asia: Xiao-Wei Jiang (50 votes)
- Co-Chair for Australia: Okke Batelaan (50 votes)

The new Board really appreciates the guidence of the Lifetime Honorary Chair, József Tóth, and thanks the past Board Members for their valuable contribution.

## 2. Mission and future plans for the new licence period

Judit Mádl-Szőnyi as the re-elected Chair formulated a suggestion for the future mission and actions of the RGFC based on the experiences of RGFC's first period of activity.

The RGFC was set up in 2011. Since then, the Commission and its activity, and what is more important, the regional groundwater flow concept, have become widely known among the members of the IAH. Besides this most significant result, a very active group has evolved through the contributions of our Canadian, Chinese, Mexican, Columbian, Autralian and Hungarian colleagues. The knowledge transfer between these active groups has been productive, and symposiums and meetings have been organized in these countries. However, this active exchange of scientific information could not involve more active members from other countries.

1) Therefore my most important intention is to broaden the number of countries from which researchers are actively involved in the understanding and use of the regional groundwater flow concept and, therefore, the activity of RGFC. We need board members from every continent, not only to represent their continent, but their task should be to actively involve scientists from different countries and help them in understanding the concept. The proposed approach to promote this involvement would be regular newsletters containing information about the news and events in the Commission. To achieve this, the RGFC needs to survey the existing knowledge of regional groundwater flow worldwide.

One of the most important tasks of the RGFC is to urge research into regional groundwater flow. I think that besides the 3D flow and heat transport models, variable recharge, and the detailed realization of complex heterogeneity previously suggested, we need more comprehensive goals.

2) We have to support theoretical and practical research in the field. Regarding theoretical research, the examination of the combined effect of different driving forces in different basin types and examine their effect on transport is also necessary, with 2D and later, even with 3D simulations. It would also be important to strengthen the link between theoretical results and their practical application in numerical solutions. Not only are the type and mechanism of flow and transport processes interesting, but also a better understanding is needed of the consequent processes and products of the interaction of flowing groundwater and the rock matrix. The role of groundwater flow as a geologic agent has not received enough attention recently. This direction can help to create an opening to geology and resource development, and to a better understanding of geological processes due to flowing fluids (like: tectonic processes, hydrocarbon migration and entrapment for both conventional and unconventional resources, geothermal processes and the accumulation of ore deposits, microbiological effects etc.). The efficiency of the research can be enhanced if the different groups (and even from different disciplines) in different countries cooperate in PhD supervision and joint research activities

The educational activity of the RGFC started in the first period of its mandate.

3) However, if we would like to help those who are not so familiar with the concept, the RGFC should find new approaches to this aspect. I think the most efficient way for this is the compilation of online educational materials for all levels of education, such as high school, university undergraduate/graduate level. These online materials, inlcuding recently published papers, could be accessible via the homepage of the RGFC. In addition to regional groundwater flow-related regular world-wide competitions, the foundation of a special prize "Best student award in Regional Groundwater Flow" could help to attract more interest.

Outreach activity has also started at a basic level in the RGFC. A joint symposium was organized by the Karst Commission and the cooperation has begun with the Outreach and Climate Change Commissions.

4) I think we have to strengthen our cooperation with other commissions and related international organizations because the regional groundwater flow concept provides a new paradigm in hydrogeology over the previous "aquifer level" way of thinking. It means that all commissions and organizations out of the IAH need to understand this concept to improve their understanding in their specific field of interest. The ECHN is a special group within IAH. I think the RGFC has to focus on the younger generation for their conceptual development. Therefore, cooperation with this group is especially important. It is also obvious to understand that the regional groundwater flow concept is necessary to all fields of hydrogeology and other related disciplines such as geology, ecology, agriculture etc.

The dissemination of knowledge about regional groundwater flow is also very significant. Besides the creation of the RGFC homepage, communication has started with the use of LinkedIn.

5) The RGFC should be more active in social media. Besides online course materials, research projects in the field should be given more publicity on Research Gate and LinkedIn. This can be used to discuss scientific and practical questions related to regional groundwater flow.

I would like to hope that by the end of the next period of activity, the regional groundwater concept will be better understood and its use will have been extended worldwide. The coordinated research will have evolved and the possibilities of its practical application will be enhanced. I also hope that hydrogeologists and scientists in related fields will recognise the significance of regional groundwater flow and the possibilities for its application.

## 3. Stand-alone Specialist Symposium

The International Symposium *Characterizing Regional Groundwater Flow Systems: Insight from practical applications and theoretical development* (26-28 June 2017, Calgary, Canada) examined the current state of the regional groundwater flow concept, discussed any recent theoretical advancement, and shared experiences from applications spanning energy exploration to environmental management. The symposium was hosted by the IAH Canadian National Chapter, and organized by the IAH Commission on Regional Groundwater Flow.


Keynote Lecture of Okke Batelaan

The two-day-long Symposium had altogether 65 oral and poster presentations and 2 keynote lectures: Okke Batelaan had a talk about the past, present and future of flow systems, and Grant Garven presented geofluids leakage along an active plate boundary. The symposium had the following session topics:

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

The syposium had also an optional 1-day field excursion in southern Alberta to learn more about the history of Canadian hydrogeology.

Distinguished guest Prof. Joe Toth – claimed himself as the dinosaur of hydrogeology – summarised the takeaway message of the fruitful and scientifically rich Symposium: "The theory is very much alive and it is broadening".

Group photo near Mud Spring Lake

## 4. Sessions at Conferences

The Regional Groundwater Flow Commission co-organized a session at the 44th IAH Congress (Dubrovnik, Croatia) entitled *Groundwater management and energy source development in a changing climate* (T 1.2). The oral and poster sessions attracted several contributions in a wide range of topics including surface water-groundwater interaction, managed aquifer recharge, groundwater management, numerical and geochemical analysis and predicted effects of climate change. The session was conveyed by Ádám Tóth (Eötvös Loránd University, Budapest, Hungary, RGFC Secretary) and Roland Barthel (University of Gothenburg, Sweden).

Regional groundwater theory was also included in other topics and sessions such as karst hydrogeology, hydrochemistry of thermal and mineral waters and groundwater-dependent ecosystems. During the social events and breaks, the Commission willingly offered its support to the organisers of the upcoming IAH Congress held in Daejeon, South Korea.

The representatives proposed some topics and possible sessions to enrich the Korean Congress. The details of the planned CRC blue book was also discussed with Janjaap Blom (CRC Press). The need of cooperation between Groundwater and Energy and Regional Groundwater Flow Commissions was realized as well.

## 5. Dissemination of Knowledge

Ádám Tóth, our Secretary, had an educational lecture about groundwater fundamentals and state of groundwater in Hungary. The presentation was entitled *Groundwaters in Hungary* and held at the Focus on Water summer school (9-22 August, Budapest) which was attended by 20 Japanese and 15 Hungarian students. The basic theory of groundwater flow was outlined and consequences of flowing groundwater, such as geothermal energy, landslides, speleogenesis, and vegetation, were presented via Hungarian case studies. The lecture was followed by a cave walk in the Szemlő-hegy cave where the hypogenic speleogenesis caused by hot water could be seen in the field.

RGFC launched its LinkedIn page, which is a forum for scientific discussion, in autumn of 2014 and since then the number of members has reached 284 (35 new members during this report period).

The Groundwater Law Proposal for Mexico includes the flow systems as the key for groundwater management in Mexico, it is in the lobby process with the High and Lower houses of the Mexican Government. (Carmona-Lara, C., Carrillo-Rivera, J.J., Hatch-Kuri, G., Huizar-Álvarez, R., Ortega-Guerrero, M.A. 2017: Ley del Agua Subterránea: una propuesta. UNAM, Impretei, SA de CV, ISBN: 978-607-02-8997-2.)

## 6. Training workshops, short courses

Tunisian Committee of Hydrology in cooperation with the Association of Water and Development of Tunisia and the University of Geography of Mexico organized a workshop on *Modelling for Sustainable Groundwater Management* 23–27 October 2017, Tunis, Tunisia. The workshop topics included Groundwater modelling: Conceptualization, Calibration, and Optimization, Groundwater management, Groundwater vulnerability to contaminants and Hydrochemistry, and Multi Criteria Decision Analysis, GIS and Remote Sensing.

Attendees of the Tunis workshop

- The need of groundwater flow understanding in Water security. Talk on the Workshop on Enhancing regional water security in semi-arid regions through improved metropolitan design. 14–17 November 2017, Oaxaca, México. Organized by British Council (Research Links), Newton Fund, Conacyt, British Geological Survey, National Autonomous University of Mexico
- Carrillo-Rivera, J.J. 2017: Challenges of science for groundwater management in Mexico. Invited lecture. Hydrogeology, School of Geography, Earth and Environmental Sciences, Birmingham University, UK, 6 December 2017
- Carrillo-Rivera, J.J. 2017: Groundwater flow systems and the importance of vertical flow. Short Workshop. Hydrogeology, School of Geography, Earth and Environmental Sciences, Birmingham University, UK, 5 December 2017

Participants of the workshop at Birmingham University

## 7. Awards

The Robert N. Farvolden Award is used to honour outstanding contributions to the disciplines of earth science and engineering that emphasize the role or importance of groundwater. In 2016, our new Co-Chair, René Lefebvre received the prize. He had his Farvolden Award acceptance speech about regional groundwater resources management in October 2017 at the IAH Canada meeting.

## 8. Future plans – Congress sessions

International Water Forum Conference 2018

The *International Water Forum Conference* is a bi-annual scientific international conference concentrating on the understanding of the water sources, groundwater functioning, water resources, engineering, management, and technology. This conference encourages the participation of experts and scholars in the corresponding fields. IWFC-2018 will be held in Hammamet, Tunisia, 19–21 March 2018. The conference aims to provide a platform for experts, professionals, researchers, students as well as decision makers in related areas to share updated information and to stimulate a scientific discussion and an environmentally orientated communication among participants. RGFC is organizing a session and a meeting entitled *Application of flow systems in the MENA Region*.

EGU General Assembly 2018

The RGF Commission is also co-organizing a session at the EGU General Assembly, 8–13 April 2018, Vienna, entitled *HS8.2.4 Groundwater flow understanding in water management: Environmental problems and potential interactions with subsurface water ecosystems.* The session aims to bring together scientists studying different aspects related to groundwater circulation and management. Understanding of gravitational groundwater flow requires knowledge of the prevailing flow system from the local to a regional scale. Moreover, problems connected to groundwater management underline the importance of sustainable development of groundwater. The understanding of deep groundwater flow is challenging, as the characterization of large flow systems is difficult due to limited data, especially in the intermediate zone between shallow aquifers and deep anthropogenic activities. Therefore, the combined use of hydraulic, geochemical, geophysical and microbiological characterizations is required to understand the functioning and effects of deep flow on shallow subsurface ecosystems. In this context, the session intends to analyze issues connected to groundwater management and its protection from qualitative and quantitative degradation (e.g. overexploitation, climate change and its consequences on groundwater, and groundwater contamination …) in the context of groundwater flow understanding. Papers related to methods of defining groundwater flow, preventing, controlling and mitigating negative environmental impacts related to groundwater are also welcome. This session is supported by RGFC and seems to be very promising,

because received 52 abstract. Convenor: Jim LaMoreaux, co-convenors: Daniela Ducci, Manuela Lasagna, Xiao-Wei Jiang, René Lefebvre, Luc Aquilina, Judit Mádl-Szőnyi, Christine Rivard, Chrystel Dezayes, Alexis Defresne.

45th IAH Congress

The upcoming IAH Congress will be held in Daejeon, South Korea, 9–14 September 2018. The RGF Commission proposed a special session entitled *Innovation in regional groundwater flow understanding.* This session attracts abstract related to theoretical or practical aspects of regional groundwater flow. The main focus is put on innovation which can be interpreted in relation to the applied approach or method or simulation technique, theoretical development. Moreover, we are waiting abstracts demonstrating the practical application possibilities of regional groundwater flow concept in water management, mitigation of climate change or in exploration of hydrocarbons, geothermal energy and ore deposits.

Geological Society of America Annual Meeting 2018

RGFC North American regional co-Chair Dr. John Molson, together with René Therrien of Université Laval, are co-chairing a proposed Special Session at the upcoming GSA (4-7 November 2018) in Indianapolis, entitled *Advances in the development and application of hydrogeological models*. It will be co-sponsored by the GSA Karst Division.

IAH-CNC (Canadian National Chapter) Annual Meeting

RGFC North American regional co-Chairs Dr. René Lefebvre and Dr. John Molson are on the Scientific program committee of this upcoming conference, to be held in Quebec City, Canada, May 2019. The first announcement and call for session proposals has been distributed. Abstract submissions will be in the fall 2018. Please see further details on the web site: http://gacmac-quebec2019.ca/

## 9. Publications

**Papers and books**

Zijl, W., De Smedt, F., El-Rawy, M. and Batelaan, O. 2018: The Double Constraint Inversion Methodology. Equations and Applications in Forward and Inverse Modeling of Groundwater Flow. SpringerBriefs in Applied Sciences and Technology, Springer, Cham, Switzerland, 101 p. https://doi.org/10.1007/978-3-319-71342-7_7

Zhao, K.Y., Jiang, X.W., Wang, X.S., Wan, L., Wang, J.Z., Wang, H., Li, H.L. 2018: An Analytical Study on Nested Flow Systems in a Tóthian Basin with a Periodically Changing Water Table. Journal of Hydrology

Hassen, I., Hamzaoui Azaza, F., Bouhlila, R. 2018: Establishing complex compartments – aquifers connectivity via geochemical approaches towards

hydrogeochemical conceptual model: Kasserine Aquifer System, Central Tunisia. Journal of Geochemical Exploration

Wang, J.Z., Jiang, X.W., Zhang, Z.Y., Wan, L., Wang, X.S., Li, H.L. 2017: An analytical study on three-dimensional versus two-dimensional water table-induced flow patterns in a Tóthian basin. Hydrological Processes

Jiang, X.W., Sun, Z.C., Zhao, K.Y., Shi, F.S., Wan, L., Wang, X.S., Shi, Z.M. 2017: A method for simultaneous estimation of groundwater evapotranspiration and inflow rates in the discharge area using seasonal water table fluctuations. Journal of Hydrology

Havril, T., Tóth, Á., Molson, J.W., Galsa A., Mádl-Szőnyi, J. 2017: Impacts of predicted climate change on groundwater flow systems: Can wetlands disappear due to recharge reduction? Journal of Hydrology, Special Issue: Climate Change & Recharge, 2017

Janos, D., Molson, J., Lefebvre, R. 2018: Regional groundwater flow dynamics and residence times in Chaudière-Appalaches, Québec, Canada: Insights from numerical simulations. Canadian Water Resources Journal, Special Issue: Quebec PACES Projects

Carrillo-Rivera, J.J., Ouysse, S. 2017: Groundwater Salinity Due to Urban Growth. Approval of review to Contribution in Encyclopedia of Sustainability Science and Technology

Hatch Kuri, G., Schmidt Nevdedovich, S., Carrillo-Rivera, J.J. 2017: Elementos de análisis de la propuesta de Ley General de Aguas en México a partir del Derecho Humano al Agua y sus repercusiones en el quehacer científico, docente y en la Investigación. Revista del Colegio de San Luis Nueva Época, año VII, ISSN 1665-899X enero-junio; pp30-62

Jarray, H., Zammouri, M., Ouessar, M., Hamzaoui Azaza, F., Barbieri, M., Zerrim, A., Soler, A., Yahyaoui, H. 2017: Groundwater vulnerability based on GIS approach: Case study of Zeuss-Koutine aquifer, South-Eastern Tunisia: Geofísica Internacional 56/1, pp 7-12

Hassen, I., Gibson, H., Hamzaoui, F., Negro, F., Khanfir, R., Bouhlila, R. 2017: Accurate 3D Geological Modelling for a Better Assessment of Groundwater Resources: A Case Study from the Kasserine Aquifer System (KAS), Central Tunisia. Fast time 22/3, pp 99–108

Hamzaoui Azaza, F., Trabelsi, R., Bouhlila, R., Khanfir, H. 2017: Evaluation of Groundwater Quality and Its Suitability for drinking and Irrigation use in semi arid region using GIS: case study: Skhira coastal aquifer, center east Tunisia. Solutions to water challenges in Mena region. ISBN978-3- 7369-9559- 8

Ameur, M., Hamzaoui Azaza, F., Moncef, G. 2017: Assessment of Drinking water quality in Oued Rmel aquifer in Zaghouan In northeastern Tunisia, through Geographic

information system and water quality index. Solutions to water challenges in Mena region. ISBN978-3- 7369-9559- 8

Hassen, I., Hamzaoui Azaza, F., Bouhlila, R. 2017: Hydrogeochemical and isotopic investigations for evaluation of the impact of climate change on groundwater quality, a case study of the Plaine of Kasserine, Central Tunisia: In book: Groundwater and Global Change in the Western Mediterranean Area. Environmental Earth Sciences. Congress on Groundwater and Global Change in the Western Mediterranean, Granada, Spain, November 2017

Mádl-Szőnyi, J., Erőss, A., Tóth Á. 2017: Fluid Flow Systems and Hypogene Karst of the Transdanubian Range, Hungary—With Special Emphasis on Buda Thermal Karst. In: Klimchouk A, Palmer A, De Waele J, Auler A, Audra P (eds.) Hypogene Karst Regions and Caves of the World. Graz: Springer International Publishing, pp. 267–278.

Mádl-Szőnyi, J., Czauner, B., Iván, V., Tóth, Á., Simon, Sz., Erőss, A., Bodor, P., Havril, T., Boncz, L., Sőreg, V. 2017: Confined carbonates–Regional scale hydraulic interaction or isolation? Marine and Petroleum Geology

Rey, N., Rosa, E., Cloutier, V., Lefebvre, R. 2018 : Using water stable isotopes for tracing surface and groundwater flow systems in the Barlow-Ojibway Clay Belt, Quebec, Canada. Canadian Water Resources Journal

Iván, V., Mádl-Szőnyi, J. 2017: Vulnerability assessment and its validation: the Gömör-Torna Karst, Hungary and Slovakia Geological Society, London, Special Publications, 466

Kovács, J., Erőss A. 2017: Statistically optimal grouping using combined cluster and discriminant analysis (CCDA) on a geochemical database of thermal karst waters in Budapest. Applied Geochemistry 84, pp. 76–86.

## Conference Presentations

Hamzaoui Azaza, F., Trabelsi, R., Bouhlila, R., Khanfir, H. 2017: Groundwater management of Skhira Aquifer (Center East of Tunisia) : Flow modeling. Regional workshop on Water efficient cities, Marrakech, Morocco, November 2017

Huchet, F., Rivard, C., Lefebvre, R., 2017 : Hydrogeological characterisation above two gas fields, Moncton sub-basin, southern New Brunswick. GeoOttawa 2017, 70th Canadian Geotechnical Conference and 12th Joint CGS/IAH-CNC Groundwater Conference, Canadian Geotechnical Society (CGS) and Canadian National Chapter of the International Association of Hydrogeologists (IAH-CNC), October 1-4, 2017, Ottawa, Canada, 8 p.

Balogh, V., Simon, Sz., Tóth, Á. 2017: Role of fluid driving forces in large sedimentary basins — case study from the Pannonian Basin, Hungary. In: Kristijan Posavec, Tamara Marković (eds.) 44th Congress of International Association of Hydrogeologists - Book of abstracts. Dubrovnik, Croatia, 25–29 September 2017

Havril, T., Tóth, Á., Mádl-Szőnyi, J., Molson, J. 2017: Effects of hydrological extremes and climate change on surface water – groundwater interaction: Example of the Tihany Peninsula, Hungary. In: Kristijan Posavec, Tamara Marković (eds.) 44th Congress of International Association of Hydrogeologists - Book of abstracts. Dubrovnik, Croatia, 25–29 September 2017

Tóth, Á., Szathmári, S., Osváth, V., Mádl-Szőnyi, J. 2017: Comprehensive hydrogeological study to reveal groundwater-dependency of the largest lacustrine ecosystem in Central Europe. In: Kristijan Posavec, Tamara Marković (eds.) 44th Congress of International Association of Hydrogeologists - Book of abstracts. Dubrovnik, Croatia, 25–29 September 2017

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Bodor, P., Anda, D., Burkus, V., Horváth, Á., Kuzmann, E., Homonnay, Z., Futó, I., Makk, J., Mádl-Szőnyi, J. 2017: Evolution of bacterial biofilms and chemical precipitates in thermal springs depending on flow kinetics (Buda Thermal Karst, Hungary). In: Kristijan Posavec, Tamara Marković (eds.) 44th Congress of International Association of Hydrogeologists - Book of abstracts. Dubrovnik, Croatia, 25–29 September 2017

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Erőss, A., Czauner, B., Erhardt, I., Ötvös, V., Simon, Sz., Mádl-Szőnyi, J. 2017: Hydrogeological controls on hypogenic cave formation – case study from Budapest (Hungary). In: Kristijan Posavec, Tamara Marković (eds.) 44th Congress of International Association of Hydrogeologists - Book of abstracts. Dubrovnik, Croatia, 25–29 September 2017

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Batelaan, O., Bresciani, E. 2017: Regional groundwater flow systems: Past, present and future. In: Brian Smerdon, Ádám Tóth, Judit Mádl-Szőnyi (eds.) Characterizing regional groundwater flow systems: Insight from practical applications and theoretical development. Calgary, Canada, 26–28 June 2017

Laurencelle, M., Lefebvre, R., Molson, J., Parent, M. 2017: Paleo-hydrogeological evolution of a fractured-rock aquifer following the Champlain Sea Transgression in the St. Lawrence Valley (Canada). In: Brian Smerdon, Ádám Tóth, Judit Mádl-Szőnyi

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Janos, D., Molson, J., Lefebvre, R., Benoit, N., Numerical simulations of regional groundwater flow and residence time distributions in the Chaudière-Appalaches region, Québec. In: Brian Smerdon, Ádám Tóth, Judit Mádl-Szőnyi (eds.) Characterizing regional groundwater flow systems: Insight from practical applications and theoretical development. Calgary, Canada, 26–28 June 2017

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Mádl-Szőnyi, J., Czauner, B., Iván, V., Tóth, Á., Simon, Sz. 2017: Significance of the understanding of regional pressure regimes in geothermal exploration for confined carbonate reservoirs. In: Brian Smerdon, Ádám Tóth, Judit Mádl-Szőnyi (eds.) Characterizing regional groundwater flow systems: Insight from practical applications and theoretical development. Calgary, Canada, 26–28 June 2017

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Budapest, 12 February 2018

Ádám Tóth, Secretary of RGFC

Judit Mádl-Szőnyi, Chair of RGFC