miniRUEDI Symposium 2023

Eawag, 8600 Dübendorf, Switzerland

Tuesday, 21 Nov 2023

9:30 – 10:00	Welcome coffee and snacks
10:00 – 10:50	Presentations
11:50 – 11:10	Break
11:10 – 12:00	Presentations
12:00 – 14:00	Lunch at Eawag
14:00 – 15:15	Presentations
15:15 – 15:45	Break
15:45 – 17:00	Presentations

Wednesday, 22 Nov 2023

9:30 – 10:00	Coffee and snacks
10:00 – 10:50	Presentations
11:50 – 11:10	Break
11:10 – 12:00	Presentations
12:00 – 14:00	Lunch at Eawag
14:00 – 15:15	Presentations
15:15 – 15:45	Break
15:45 – 17:00	Presentations
19:00 (open end)	Group dinner in Zürich

Thursday, 23 Nov 2023

9:30 – 10:00	Coffee and snacks
10:00 – 10:50	Presentations
11:50 – 11:10	Break
11:10 – 12:00	Presentations
12:00 – 14:00	Lunch at Eawag
14:00 – 15:15	miniRUEDI hands-on, lab tour

End of miniRUEDI Symposium

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River rafting with the miniRUEDI

Connor P. Newman, Eric C Humphrey, Matthias S Brennwald, W. Payton Gardner, Kelli M Palko and Michael N Gooseff

Eawag, USGS

Saline geothermal systems in the western United States are major sources of solutes that negatively affect downstream water use. Discharge from these systems is commonly manifested as both discrete springs and diffuse outfow along the riverbed. Discrete discharges may be quantified using physical measurements, but large diffuse discharges are difficult to quantify. To quantify total discharge from several large saline geothermal systems in the Upper Colorado River Basin high-resolution noble gas measurements were made from a boat-mounted portable gas equilibrium membrane-inlet mass spectrometer (miniRUEDI) in two locations in the western United States: the Colorado River near Glenwood Canyon and the Virgin River near Pah Tempe springs. Geothermal discharge in both locations has distinctive noble gas signatures, with He concentrations in springs enriched three orders of magnitude above atmospheric equilibrium (about 10^{-5} ccSTP/g). We hypothesize that the enriched He concentrations of discrete (springs) and diffuse (riverbed) discharge from these systems will have an influence on the noble gas composition of river water, allowing for the total geothermal discharge in each location to be quantified by helium mass balance. Continuous noble gas measurements also allow for direct estimation of the air/water He gas transfer rate), which commonly requires time-consuming gas injections. Results from the Glenwood Canyon area indicate that He concentrations in the river undergo an order of magnitude increase (to about 10^{-7} ccSTP/g). Elevated helium concentrations in the river extend kilometers downstream from mapped inflows and indicate substantial diffuse inflows or slow degassing of geothermal He. Mass balance modeling accounting for helium inflow and degassing indicates a total geothermal discharge of 425 to 850 L/s, compared to a previous estimate of 300 L/s from discrete springs. Results from the Pah Tempe area indicate He concentration in the river enriched two orders of magnitude above atmospheric equilibrium (up to about 10^{-6} ccSTP/g). Geothermal discharge to the Virgin River in this reach is estimated at approximately 250 L/s, similar to the flux measured by differential gaging. Data allow for estimation of the He gas transfer rate in the Colorado River (40 m/d) and Virgin River (80 m/d), illustrating the utility of the high-resolution measurements in quantifying this important parameter.

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Presenting the Omnistar

Edith Engelhardt

Institut für Umweltphysik, Universität Heidelberg

We present data from gas measurements in air and water conducted with the Omnistar, a commercially available mobile mass spectrometer by Pfeiffer Vacuum. Over the years, several MiniRuedi-inspired changes and improvements were made to the system by our group to make the Omnistar available for measurements in water as a GE-MIMS and to reduce fractionation processes. We would be happy to discuss potential and limitations of the Omnistar and receive input for improvements from more experienced GE-MIMS users.

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Geochemical Background of Volatiles in Kyejo Area (Rungwe Volcanic Province) and Geochemical Composition of Soil Gas, Macro Seep and Gas Vent: Implication to CO2 Prospect

Karim Mtili

University of Dar es Salaam

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In situ observation of helium and argon release during fluid-pressure-triggered rock deformation

Clément Roques

University of Neuchatel

Temporal changes in groundwater chemistry can reveal information about the evolution of flow path connectivity during crustal deformation. Here, we report transient helium and argon concentration anomalies monitored during a series of hydraulic reservoir stimulation experiments measured with an in situ gas equilibrium membrane inlet mass spectrometer. Geodetic and seismic analyses revealed that the applied stimulation treatments led to the formation of new fractures (hydraulic fracturing) and the reactivation of natural fractures (hydraulic shearing), both of which remobilized (He, Ar)-enriched fluids trapped in the rock mass. Our results demonstrate that integrating geochemical information with geodetic and seismic data provides critical insights to understanding dynamic changes in fracture network connectivity during reservoir stimulation. The results of this study also shed light on the linkages between fluid migration, rock deformation and seismicity at the decameter scale.

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Long term monitoring of noble gas and water isotope tracers in a localised MAR scheme to assess recharge and regional groundwater mixing dynamics

Jared van Rooyen

Eawag

Managed aquifer recharge (MAR) has become increasingly popular in Central Europe as a sustainable, clean, and efficient method for managing domestic water supply. In these schemes, river water is artificially infiltrated into shallow aquifers for storage and natural purification of domestic water supply, while the resulting groundwater mound can simultaneously be designed such that it suppresses inflow of regional groundwater from contaminated areas. MAR schemes are typically not managed based on automated optimization algorithms, especially in complex urban and geological settings. However, such automated managing procedures are critical to guarantee safe drinking water. With (seasonal) water scarcity predicted to increase in Central Europe, improving the efficiency of MAR schemes will contribute to achieving several of the UN SDGs and EU agendas. Physico-chemical and isotope data has been collected over the last 3-4 decades around Switzerland's largest MAR scheme in Basel, Switzerland, where 100 km3/d of Rhine river water are infiltrated and 40 km3/d are extracted for drinking water. The other 60 km3/d are used to maintain the groundwater mound that keeps locally contaminated groundwater from industrial heritage sites out of the drinking water. The hydrochemical/isotope data from past and ongoing studies were consolidated to contextualize all the contributing water sources of the scheme before online noble gas and regular tritium monitoring commenced in the region. The historical and the new continuous tracer monitoring data is now used to inform new sampling protocols and create tracer enabled/assimilated groundwater-surface water flow models, vastly helping algorithm-supported MAR optimization.

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Analyzing Unexpected Gas Seep in Mbeya, Tanzania with a Portable Mass Spectrometer ("MiniRuedi")

Clarah Kimani

University of Dar es Salaam

A study was conducted in Mbeya region Tanzania, to investigate unexpected gas seepage from a dry well at Harrison Uwata Girls Secondary School. Gas samples were collected and analyzed using a portable mass spectrometer ("MiniRuedi"), an analytical instrument to determine their composition. The study focused on the Rungwe Volcanic Province (RVP), situated within the East African Rift System, known for active magmatic activity, including vigorous gas and volatiles emanations. The primary gas in the seep was found to be carbon dioxide (CO2), with trace amounts of nitrogen (N2), argon (Ar), and helium (He). The analysis traced the sources of these gases to contributions from both the Earth's atmosphere and the subsurface, particularly the Earth's mantle. The concentration of CO2 in the seep was found to vary based on proximity to volcanic centers, with closer locations having higher CO2 concentrations (90%). This decrease in CO2 concentration with distance was attributed to dilution by other gases from sources like the atmosphere and the Earth's crust. The study emphasizes the importance of understanding the origin of CO2 in these seeps and calls for further research to explore its nature, storage, and potential economic extraction and utilization as a resource.

The investigation at Harrison Uwata Girls Secondary School gas seep in the RVP has significant implications for understanding the geology, geochemistry, and geological processes in the area and the broader East African Rift System, offering opportunities for future research and resource exploration. Additionally, the study highlights the presence of different hydrothermal systems in the RVP, including cold-gassy and hot-gaseous systems, with varying characteristics and potential hazards.

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Results of gas measurements during a pump test in Cornwall

Bettina Strauch and Martin Zimmer

GFZ Potsdam

Within the EU funded project "CRM geothermal", that aims to establish an overview of the potential of geothermal fluids for raw material extraction, a pump test was conducted at a drill site in Cornwall, UK to assess the composition of the produced geothermal liquid. The borehole was drilled in 2019 to 1100m depth by Cornish Lithium Company in United Downs, Cornwall, UK for lithium exploration. The well crosses two permeable structures at approximately 600 m and 1011 m where low-salinity geothermal waters are hosted in natural fractures of granite and a metamorphic aureole. The water has an elevated lithium concentration due to the dissolution of lithium-enriched minerals in the granite. During a test campaign in summer 2023, a production test was conducted from 19/06/2023 to 22/06/2023. Beside the dissolved ions, also the gas composition was monitored during pumping operation. The focus was here on Helium which is of economic importance and, in view of emerging digital applications, assumed to become critical (high demand, low availability). An elevated helium content in the produced gas was expected, as the host granite contains large amounts of radionuclides, such as Uranium and Thorium, that results in Helium production upon decay. The sampling campaign was accompanied by an online gas monitoring of the headspace gas using the MiniRuedi. Furthermore, the GMIMS was used for gas-water separation. In addition, experiments addressing the option of online-helium extraction using an alternative membrane-based gas extraction method, were performed. A conventional gas sampling for lab-based analyses was completed as well. The data showed up to 1 vol.% Helium and a good agreement between different extraction and measurement techniques. can be attested. The data evaluation is still ongoing and preliminary results will be presented.