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INVITATION

to the **53rd** Meeting of Young Geoscientists

31 March – 1 April 2023

Nagybörzsöny
Malomkert Hotel, Restaurant and Service Center

Useful information:

Accommodation and meals are available only for pre-registered participants.
The talks are open and public.
Official languages of the conference are English and Hungarian.

Registration desk open: from 8:00 am, 31st March 2023 onwards

Organisers

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MEGHÍVÓ

az **53.** Ifjú Szakemberek Ankétjára

2023. Március 31 – Április 1.

Nagybörzsöny
Malomkert Hotel, Étterem és Rendezvényközpont

Tudnivalók:

Szállást és étkezést csak az előre regisztrált résztvevőknek tudunk biztosítani.

Az ankét programja szabadon látogatható.

A konferencia hivatalos nyelve angol és magyar.

Regisztrálás: 2023. Március 31. 8:00-tól folyamatosan

Rendező Bizottság

PROGRAMME

31 MARCH 2023, FRIDAY

09^{00} - 09^{10}	OPENING
09^{10} - 11^{00}	1^{ST} SESSION
11^{15} - 13^{05}	2^{ND} SESSION
13^{20} - 14^{20}	POSTER SESSION – SHORT ORAL SUMMARIES
14^{20} - 15^{20}	LUNCH
15^{20} - 17^{10}	3^{RD} SESSION
17^{25} - 19^{15}	4^{TH} SESSION
19^{15} - 20^{30}	POSTER SESSION – DISCUSSION
20^{30}	DINNER

1. APRIL. 2023. SATURDAY

- 10^{00}	CHECK-OUT FROM THE ROOMS *Please leave your room after breakfast, until 10 o'clock. The baggages can be stored in a luggage room.*
07^{00} - 09^{30}	BREAKFAST
09^{30} - 11^{20}	5^{TH} SESSION
11^{35} - 13^{10}	6^{TH} SESSION
13^{10} - 14^{30}	LUNCH
14^{30}	AWARD GIVING AND CLOSING CEREMONY

FRIDAY

09^{00} OPENING

09^{10}- 11^{00} 1ST SESSION

09^{10} *Cyclostratigraphy and eccentricity orbital forcing of the middle Miocene Kareem Formation, Gulf of Suez, Egypt: Implications of astronomical age dating and undetected hiatus*

A **Ahmed Abdeldaim Ewaida Oraby**[1,2]

[1]Master student, University of Miskolc, Faculty of Earth and environmental science and engineering, Miskolc, Hungary; [2]South Valley University, Faculty of Science, Geology Department, Qena, Egypt

09^{25} *Dynamic geomorphometric study of the erosion of the Zagyvarona spoil tip using digital photogrammetry*

A **Máté Dániel Petróczy**[1,2], Boudewijn Van Leeuwen[1], Zoltán Tobak[1], Dávid Molnár[2], József Szatmári[1]

[1]Department of Geoinformatics, Physical and Environmental Geography, University of Szeged, Egyetem u. 2-6, H-6722 Szeged, Hungary; [2]Department of Geology and Paleontology, University of Szeged, Egyetem u. 2-6, H-6722 Szeged, Hungary

09^{40} *Numerical modelling and mapping of Miocene dyke opening in the Cserhát Hills, Hungary*

T **Dorina Juhász**[1], Chiara Lanzi[2], Kitti Váradi[1,3], Márk Szijártó[3], László Fodor[1,4], Freysteinn Sigmundsson[2]

[1]Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Geology; [2]Nordic Volcanological Center, Institute of Earth Sciences, University of Iceland; [3]Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Geophysics and Space Science; [4]ELKH Research Network, Institute of Earth Physics and Space Science

09^{55} *Well log categorisation with artificial neural network*

A **András Hegedüs**[1]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, Budapest, Hungary

10^{10} *Relationship between thermal dispersion and heterogeneity of porous media in a synthetic geothermal well doublet*

T **Bence Molnár**[1], Attila Galsa[1]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, Budapest, Hungary

10^{25} *A robust clustering technique assisted interval inversion of well-logging data for automatic determination of formation boundaries*

T **Moataz Mohamed G. Abdelrahman**[1], Norbert Péter Szabó[1]

[1]University of Miskolc, Department of Geophysics, Faculty of Earth Science and Engineering, Miskolc, Hungary

10^{40} DISCUSSION

11^{00}- 11^{15} BREAK

11^{15}- 13^{05} 2ND SESSION

11^{15} *Estimation of the parameters of a lunar ellipsoid of revolution based on GRAIL selenoid data and Fibonacci mesh*

T **Cziráki Kamilla**[1]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, Budapest, Hungary

11^{30} *Modern inversion tools for evaluating unconventional hydrocarbon reservoirs*

T **Rafael Valadez-Vergara**[1]

[1]University of Miskolc, Faculty of Earth and Environmental Sciences and Engineering, Department of Geophysics, Miskolc, Hungary

11^{45} *Investigating the agricultural applicability of interferometric coherence*

A **Jázmin Sipőcz**[1]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, Budapest, Hungary

12^{00} *Cases study of Petrophysical rock typing and Permeability prediction*

A **Hassan Hadeer**[1], Mihály Dobróka[1]

[1]University of Miskolc, Department of Geophysics, Faculty of Earth Science and Engineering, Miskolc, Hungary

12[15] *Using electrical borehole image logs in hydrocarbon reservoir parametrization of thin bedded, laminated shaly sandstones*

A **Nándor Szegedi**[1]

[1]MOL Hungarian Oil and Gas Plc., Nagykanizsa, Hungary

12[30] *Trace element and isotope signatures of sulfides from all mineralized zones of a porphyry-skarn-epithermal system*

T **Máté Biró**[1], Ferenc Molnár[1], Hugh O'Brien[2]

[1]Eötvös Loránd University, Faculty of Science, Department of Mineralogy; [2]Geological Survey of Finland, GTK, Espoo Finland

12[45] DISCUSSION

13[05]- 13[20] BREAK

13[20]- 14[20] POSTER SESSION – short oral summaries

13[20] *PCA-based soil geochemical investigation of precious metals in Rudabánya, Hungary: Uncovering the hidden relationships*

P **Mohamed Abdelnaby Oraby**[1,2], Földessy János[1]

[1]Institute of Mineralogy and Geology, Faculty of Earth Sciences and Engineering, University of Miskolc, Hungary; [2]Department of Geology, Faculty of Science, Ain Shams University, Egypt

13[23] *Evolution and relation of Black Belly tuff-cone, North-Tanzania*

P **Noémi Halász**[1], Tivadar M. Tóth[1]

[1]University of Szeged, Szeged, Hungary

13[26] *Background effects and suppression in muographic measurements*

P **Bencze Rábóczki**[1,2]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Budapest, Hungary; [2]Wigner Research Centre for Physics

13[29] *Data analysis of the MTOA-02 base magnetotelluric section*

P **Renáta Szebenyi**[1,2], János Kiss[2]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Budapest, Hungary; [2]Supervisory Authority for Regulatory Affairs, Hungary

13[32] *Deep CO_2-rich gas emanation in the Southeastern Carpathians*

P **Thomas Pieter Lange**[1,2,3,4], László Palcsu[5], Alexandru Szakács[6], Ákos Kővágó[2,7], Orsolya Gelencsér[2,3], Ágnes Gál[8], Sándor Gyila[9], Tivadar M. Tóth[10], Liviu Mațenco[11], Csaba Krézsek[12], László Lenkey[13], Csaba Szabó[1,2], István János Kovács[1,4]

[1]Institute of Earth Physics and Space Science, Eötvös Loránd Research Network, Budapest, Hungary; [2]Lithosphere Fluid Research Lab, Institute of Geography and Earth Sciences, Eötvös Loránd University, Budapest, Hungary; [3]Doctoral School of Environmental Sciences, Eötvös Loránd University, Budapest, Hungary; [4]MTA FI Lendület Pannon LitH_2Oscope Research Group, Hungary; [5]Isotope Climatology and Environmental Research Centre, Institute for Nuclear Research (ATOMKI), Debrecen, Hungary; [6]Institution of Geodynamics, Romanian Academy, Bucharest, Romania; [7]Doctoral School of Earth Sciences, Eötvös Loránd University, Budapest, Hungary; [8]Department of Geology, Babeș-Bolyai University, Cluj-Napoca, Romania; [9]Dr. Benedek Géza Rehabilitation Hospital, Covasna, Romania; [10]Department of Mineralogy, Geochemistry and Petrology, University of Szeged, Hungary; [11]Utrecht University, Faculty of Geosciences, Utrecht, the Netherlands; [12]OMV Petrom, Bukarest, Romania; [13]Department of Geophysics and Space Science, Eötvös Loránd University, Hungary.

13[35] *Preliminary results of numerical modelling and time series analysis to quantify the neglected groundwater component in Lake Velence's water budget*

P **Petra Baják**[1], Katalin Hegedűs-Csondor[1], András Csepregi[2], Anita Erőss[1]

[1]József and Erzsébet Tóth Endowed Hydrogeology Chair, Department of Geology, Institute of Geography and Earth Sciences, Faculty of Science, ELTE Eötvös Loránd University, Budapest, Hungary; [2]Hydrosys Ltd., Budapest, Hungary

13[38] *Energy storage in hydrogen, hydrogen storage in porous rocks*

P **Orsolya Gelencsér**[1,2,3], Csaba Árvai[4], Zsuzsanna Szabó-Krausz[2]

[1]Doctoral School of Environmental Sciences Eötvös Loránd University Budapest, Hungary; [2]Lithosphere Fluid Research Lab, Eötvös Loránd University Budapest; [3]O&GD Central Ltd. Budapest; [4]Department of Chemical and Environmental Process Engineering, Budapest University of Technology and Economics, Budapest

13[41] *Permian-Triassic red sandstones from the Balaton Highlands and the Mecsek Mountains. Comparative micromineralogical and geochemical study*

P **Dóra Georgina Miklós**[1,2], Sándor Józsa[2], Zsolt Kasztovszky[3], Ildikó Harsányi[3], Katalin Gméling[3], Zoltán Kovács[3], György Szakmány[2]

[1]Hungarian National Museum, National Institute of Archaeology, 1113, Budapest; [2]Eötvös Loránd University, Department of Petrology and Geochemistry, 1117, Budapest; [3]Nuclear Analysis and Radiography Department Centre for Energy Research (KFKI), Budapest

13[44] *Supply-induced transgression in endorheic lakes: a fundamental difference between lacustrine and marine settings*

P **Ádám Kovács**[1], Attila Balázs[2], Orsolya Sztanó[1]

[1] ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Geology, Budapest, Hungary; [2]Department of Earth Sciences, ETH Zurich, Zurich, Switzerland

13[47] *Hilbert transformation using Chebyshev polynomials with IRLS*

P **Omar Al Marashly**[1], Mihály Dobróka[1]

[1]University of Miskolc, Institute of Geophysics and Geoinformatics, Miskolc, Hungary

13[50] *Economic potentiality of heavy mineral sands in the Pannonian Basin – A case study*

P **Bence Arnold Korondi**[1], Sándor Józsa[1], Anikó Váczi-Lovász[2]

[1]Eötvös Loránd University, Department of Petrology and Geochemistry, Budapest, Hungary; [2]Eötvös Loránd University, Faculty of Science, Doctoral School of Earth Sciences, Budapest, Hungary

13[53] *Environmental history of Lake Kolon based on sedimentological analysis*

P **Tamás Zsolt Vári**[1], Pál Sümegi[1,2]

[1]Department of Geology and Paleontology, University of Szeged, 2-6. Egyetem street, Szeged, Hungary; [2]Hertelendi Laboratory of Environmental Studies, Institute of Nuclear Research of Hungarian Academy of Sciences, Debrecen, Bem tér 18/C, Hungary

13[56] *Defining strarigraphic units for regional hydrogeological model*

P ***Julianna Mekker***[1]

[1]Supervisory Authority of Regulatory Affairs, Budapest, Hungary

13[59] *Elastic thermobarometry on quartz and zircon inclusions from a high-pressure granulite of the Cabo Ortegal Complex: a novel approach*

P **Tamás Spránitz**[1,2], Csaba Szabó[1,2], Mattia Gilio[3], Matteo Alvaro[3], Michaela Blažeková[4], Patrik Konečný[4], Tamás Váczi[5], Márta Berkesi[1,2]

[1]Lithosphere Fluid Research Lab, Faculty of Sciences, Eötvös Loránd University, Pázmány Péter sétány 1/C, Budapest 1117, Hungary ; [2]MTA FI Lendület FluidsByDepth Research Group, Institute of Earth Physics and Space Science (EPSS), 9400 Sopron, Csatkai Endre utca 6-8, Hungary.; [3]Department of Earth and Environmental Sciences, University of Pavia, Pavia, Italy; [4]State Geological Institute of Dionýz Štúr, 817 04 Bratislava, Slovakia; [5]Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, P.O. Box 49, H-1121 Budapest, Hungary

14[02] *Subsurface Temperature Model of Hungary*

P **Tamás Lukács**[1]

[1]Supervisory Authority of Regulatory Affairs, Budapest, Hungary

14[05] *Evaluating the detection efficiency of the BlitzOrtung network and studying the lightning climatology over Hungary*

P **Attila Buzás**[1,2], Tamás Bozóki[1,3], József Bór[1]

[1]Institute of Earth Physics and Space Science (EPSS), Sopron, Hungary; [2]Doctoral School of Earth Sciences, Faculty of Science, Eötvös Loránd University, Budapest, Hungary; [3]Department of Optics and Quantum Electronics, University of Szeged, Szeged, Hungary

14[08] *Evolution and water content of the Firiza calc-alkaline basalts, Gutai Mts., North-Eastern Carpathians*

P **Ákos Kővágó**[1,2], Marinel Kovacs[3], Csaba Szabó[2, 4], István János Kovács[2, 4]

[1]Doctorate School of Earth Sciences, Eötvös Loránd University, Hungary, 1117 Budapest, Pázmány Péter sétány 1/C.; [2]Lithosphere Fluid Research Lab (LRG), Eötvös Loránd University, Hungary, 1117 Budapest, Pázmány Péter sétány 1/C.; [3]Technical University Cluj-Napoca, Northern University Centre, Romania, Baia Mare; [4]ELKH Institute of Earth Physics and Space Science, Hungary, 9400 Sopron, Csatkai Endre u. 6-8

14^{11} *Predicting the "geothermal reinjection potential" into a deltaic reservoir formation in the Zala region (SW Hungary) based on the datasets of the hydrocarbon industry*

P **Ábel Markó**[1,2], Marianna Tóth[2], Maren Brehme[3], Judit Mádl-Szőnyi[1]

[1]Department of Geology, Institute of Geography and Earth Sciences, ELTE Eötvös Loránd University Budapest, Hungary; [2]MOL Hungarian Oil and Gas Company, Budapest Hungary; [3]Geothermal Energy and Geofluids, Department of Earth Sciences, ETH Zürich, Switzerland

14^{14} *Modelling of a nuclear borehole geophysics tool used for CCS monitoring measurements in sandstone reservoirs*

P **József Gábor Szűcs**[1], Attila Galsa[1], László Balázs[1]

[1]Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, ELTE Eötvös Loránd University, Budapest, Hungary

14^{17} *Assessment of geothermal potential and compilation of data packages in Hungary*

P **András Virók**[1]

[1]Supervisory Authority of Regulatory Affairs, Budapest, Hungary

14^{20}- 15^{20} LUNCH

15^{20}- 17^{10} 3RD SESSION

15^{20} *Pore network characterization and permeability estimation: application of XCT in pore network analysis and*

A **Hasan Atrash**[1], Dr. Felicitász Velledits[1]

[1]University of Miskolc, Faculty of Earth and Environmental Sciences and Engineering Geological Institute, Miskolc, Hungary

15^{35} *Numerical modelling of groundwater age in synthetic and real groundwater systems*

T **Zsuzsanna Vatai**[1], Márk Szijártó[1], Attila Galsa[1]

[1]Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, ELTE Eötvös Loránd University, Budapest, Hungary

15^{50} *Delineation of near-surface volcanics Applying turning-ray tomography and drilling date in the area of Bodrogköz*

A **Lilla Emőke Borsos**[1], Tivadar Szabó[2]

[1]Eötvös Loránd University, Department of Geophysics and Space Science; [2]Hungarian Supervisory Authority for Regulatory Affairs

16[05] *The geotouristical properties of Nagybörzsöny*

T **Thomas Pieter Lange**[1,2,3], Oszkár Paulik[4,5], Zoltán Batizi[6], Klára Felkérné Kóthay[7], Sándor Józsa[8], Tivadar M. Tóth[9]

[1]ELKH Institute of Earth Physics and Space Science; [2]Eötvös Loránd University, Environmental Doctoral School; [3]Lithosphere Fluid Research Lab (LRG), [4]Nagybörzsöny Major Office; [5]Tegyünk Együtt Nagybörzsönyért Egyesület (TENE); [6]Börzsöny Museum, Szob; [7]Eötvös Loránd Natural History Museum, Eötvös Loránd University; Department of Petrology and Geochemistry, 8Eötvös Loránd University; [9]Department of Mineralogy, Geochemistry and Petrology, Szeged University

16[20] *Using 2D balancing to quantify the scale of the Miocene extension of the Danube Basin*

T **Kitti Váradi**[1,2], László Fodor[2,3], Márk Szijártó[1], László Bereczki[4]

[1]Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, ELTE Eötvös Loránd University, Budapest, Hungary; [2]Department of Geology, Institute of Geography and Earth Sciences, ELTE Eötvös Loránd University, Budapest, Hungary; [3]ELKH Research Network, Institute of Earth Physics and Space Science, Sopron, Hungary; [4]Supervisory Authority for Regulatory Affairs, Department of Mineral Resources Research and Geophysics, Budapest, Hungary

16[35] *Paleoenvironmental reconstruction of the dinosaur localities in the westernmost part of the Haţeg Basin*

A **Soma Budai**[1], Gábor Botfalvai[2,3]

[1]Turbidites Research Group, School of Earth and Environment, University of Leeds, LS2 9JT, Leeds, UK; [2]Eötvös Loránd University, Department of Paleontology, Pázmány Péter Sétány 1/C, 1117 Budapest, Hungary; [3]ELKH-MTM-ELTE Research Group for Paleontology, Budapest, Pázmány Péter Sétány 1/C, 1117 Budapest, Hungary

16[50] DISCUSSION

17[10]- 17[25] BREAK

17[25]- 19[15] 4[TH] SESSION

17[25] *Some aspects of the interpretation of magnetic maps*

T **Khouloud Jlaiel**[1]

[1]University of Miskolc, Faculty of Earth and Environmental Sciences and Engineering Department of Geophysics, Miskolc, Hungary

17[40] *Muography direct problem modelling for geophysical applications*

T **Abigél Boglárka Stefán**[1]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, Budapest, Hungary

17[55] *Preliminary petrography and fluid inclusion data from the Ostra polymetallic mineralization (Eastern Carpathians, Romania)*

T **Boglárka B. Balázs**[1], Árpád Ádámcsik[1], István Márton[2], Szabolcs Orbán[3], Gabriella B. Kiss[1]

[1]Eötvös Loránd University, Faculty of Sciences, Institute of Geography and Geosciences, Department of Mineralogy; [2]Dundee Precious Metals Inc; [3]Goldron Geoconsulting Ltd.

18[10] *Naturally occurring radionuclides in a riverbankfiltration system – potential health threat or indicators of temporal variability*

A **Máté Márk Mezei**[1], Petra Baják[1], Endre Csiszár[2], Katalin Hegedűs-Csondor[1], Bálint Izsák[3], Márta Vargha[3], Ákos Horváth[4], Anita Erőss[1]

[1]József and Erzsébet Tóth Endowed Hydrogeology Chair, Department of Geology, Institute of Geography and Earth Sciences, Faculty of Science, ELTE Eötvös Loránd University, Budapest, Hungary; [2]Bácsvíz Ltd., Kecskemét, Hungary; [3]Public Health Directorate, National Public Health Institute, Budapest, Hungary; [4]Department of Atomic Physics, ELTE Eötvös Loránd University, Budapest, Hungary

18[25] *A detailed study of the 2D travel-time tomography problem and its application to calculate phase velocity maps*

T **Kolos Németh**[1], Máté Timkó[2]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Budapest, Hungary; [2]ELKH, FI Kövesligethy Radó Seismological Observatory

18[40] *Tectonic reconstruction and HC trap types of the North Hungarian Paleogene Basin (NHPB)*

T **Balázs Soós**[1]

[1]MOL Hungarian Oil and Gas Plc., Hungary

18[55] DISCUSSION

19[15]- 20[30] POSTER SESSION – discussion

20^{30} DINNER

SATURDAY

09^{30} - 11^{20} 5TH SESSION

09^{30} *Studying the structural hydroxyl content of nominally anhydrous minerals in South Harghita shoshonites*

T **Dániel Kovács**[1], Ágnes Gál[2], Alexandru Szakács[3], Thomas Pieter Lange[1,4,5,6], Ákos Kővágó[1,7], Csaba Szabó[1,4], István János Kovács[4,6]

[1]Lithosphere Fluid Research Lab, Institute of Geography and Earth Sciences, Eötvös Loránd University, Budapest, Hungary; [2]Department of Geology, Babeș-Bolyai University, Cluj-Napoca, Romania; [3]Institution of Geodynamics, Romanian Academy, Bucharest, Romania; [4]Institute of Earth Physics and Space Science, Eötvös Loránd Research Network, Budapest, Hungary; [5]Doctoral School of Environmental Sciences, Eötvös Loránd University, Budapest, Hungary; [6]MTA FI Lendület Pannon LitH_2Oscope Research Group, Hungary; 7Doctoral School of Earth Sciences, Eötvös Loránd University, Budapest, Hungary;

09^{45} *A thorough examination of the structural parameters for potential mineralization south of the Egyptian Golden Triangle*

A **Mohamed Badawi**[1]

[1]University of Miskolc, Institute of Mineralogy and Geology, Miskolc, Hungary

10^{00} *Variscan S-type granitoids in the Codru Nappe System (Apuseni Mts.): petrography, whole-rock geochemistry and correlations in the Tisza Mega-unit*

T **Barnabás Jákri**[1], Máté Szemerédi[1,2], Zoltán Kovács[2,3], Elemér Pál-Molnár[1,2]

[1]Department of Mineralogy, Geochemistry and Petrology, 'Vulcano' Petrology and Geochemistry Research Group, University of Szeged, Szeged; [2]MTA-ELTE Volcanology Research Group, Budapest; [3]Centre for Energy Research, Eötvös Loránd Research Network (ELKH), Budapest

10^{15} *Late-Miocene vertebrate coprolites from Pécs-Danitzpuszta*

A **Zsófia Román**[1], Martin Segesdi[1,2], Krisztina Sebe[3], Tamás Földes[4], Gábor Botfalvai[1,5]

[1]Department of Paleontology, Eötvös Loránd University, Budapest; [2]Hungarian Natural History Museum, Department of Paleontology and Geology, Budapest; [3]Department of Geology and Meteorology, University of Pécs, Pécs; [4]TOMOGEO Kft., Szolnok, 5ELKH-MTM-ELTE Research Group for Paleontology, Budapest

10^{30} *Genetic study of the sphalerite from Rudabánya (NE Hungary)*

T **Kristóf Lipp**[1], János Földessy[1], Attila Kasó[1], Gabriella B. Kiss[1]

10^{45} *Re-examination of the wehrlite from Denevér-táró at Szarvaskő, Hungary: petrographic characteristics and sulphide melt inclusions.*

T **Botond Salamon**[1]

[1]Eötvös Loránd University, Faculty of Sciences, Institute for Geography and Geology, Department of Mineralogy

11^{00} DISCUSSION

11^{20}- 11^{35} BREAK

11^{35}- 13^{10} 6TH SESSION

11^{35} *Application of Strontium and its isotopes of $^{87}Sr/^{86}Sr$ for tracing urban soil contamination, a case study of Salgótarján, Hungary*

T **Mona Maghsoudlou**[1], D. Tserendorj[1], Y. López Marín[1], G. Abbaszade[1], N. Kavasi[2,3], S.K. Sahoo[2], M. Štrok[3], K. Inoue[4], P. Völgyesi[5], E. Tóth-Bodrogi[6], T. Kovács[6], Cs. Szabó[1]

[1]Lithosphere Fluid Research Laboratory, Eötvös Loránd University, Budapest, Hungary; [2]Department of Radioecology and Fukushima Project, National Institute of Radiological Sciences, National Institute for Quantum and Radiological Science and Technology, Chiba, Japan; [3]Department of Environmental Sciences, Jožef Stefan Institute, Ljubljana, Slovenia; [4]Department of Radiological Sciences, Tokyo Metropolitan University, Tokyo, Japan; [5]Nuclear Security Department, Centre for Energy Research, Budapest, Hungary; [6]Institute of Radiochemistry and Radioecology, University of Pannonia, Veszprém, Hungary

11^{50} *A newly discovered combustion metamorphic complex in the Miocene coal-bearing sedimentary units of Salgótarján Basin, Novohrad-Nógrád UNESCO Global Geopark*

T **Laura Horváth**[1], Máté Biró[1], Sándor Vágó[1], Tamás Gábor Weiszburg[1], Péter Prakfalvi[2]

[1]Eötvös Loránd University, Department of Mineralogy, Budapest; [2]Novohrad-Nógrád UNESCO Global Geopark; Salgótarján

12[05] *Geochemistry of HFSE enriched rock bodies from Bükk Mts., NE Hungary – a geostatistical case study*

A **Csilla Balassa**[1], Norbert Péter Szabó[1], Norbert Németh[1], Ferenc Kristály[1]

[1]University of Miskolc, Institute of Exploration Geosciences, Miskolc, Hungary

12[20] *Remote Sensing Techniques for Mineral Prospecting in Ariab Area, Red Sea Hills, NE Sudan*

A **Musa M. M. Mina**[1]

[1]Eötvös Loránd University, Department of Geophysics and Space Science, Institute of Geography and Earth Sciences, Budapest, Hungary

12[35] *„Heavy mineral analysis" a useful method for the identification of the provenience of the archaeological tools made of calcareous sandstone*

T **Dóra Georgina Miklós**[1,2], György Szakmány[2], Mária Bondár[3], Gábor Ilon[4], István Eke[5], Máté László[1], Sándor Józsa[2]

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12[50] DISCUSSION

13[10]- 14[30] LUNCH

14[30] AWARD GIVING AND CLOSING CEREMONY

ABSTRACTS

1ST SESSION

Cyclostratigraphy and eccentricity orbital forcing of the middle Miocene Kareem Formation, Gulf of Suez, Egypt: Implications of astronomical age dating and undetected hiatus

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Applied

The middle Miocene Kareem Formation is one of the most important hydrocarbon reservoirs in the Gulf of Suez. The absence of clear marker species and many barren sand reservoirs or evaporite seals have remained the age of this formation to be controversial. Furthermore, the time estimation and duration of a well-known and recognized hiatus (T40) within this formation has not been defined. In the present study, a new refined astronomical tuned time scale (ATS) has been established based on an integration of foraminiferal and calcareous nannofossil biostratigraphy, with gamma-ray based cyclostratigraphic analysis of two wells, J58-81 in the July Basin and Gs197-2 in the October Basin. Six calcareous nannofossil, four planktonic, and one benthic foraminiferal bio-horizons have been defined, that enabled us to define the Langhian-Serravallian boundary. According to the new ATS, the Kareem Formation spans from 13.25 to 15 Ma. Duration of ca. 0.18 Myr and 0.26 Myr were estimated for the T40 hiatus at the Shagar/Rahmi Members boundary in both wells: J58-81 and Gs197-2, respectively. An obliquity imprint was recorded in the upper Langhian to Serravallian, right above the T40 hiatus of Gs197-2 well.

Dynamic geomorphometric study of the erosion of the Zagyvarona spoil tip using digital photogrammetry

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Applied

Large-scale mining activity took place in the Salgótarján coal basin (Nógrád county, Hungary) until the mid-1900s. The byproducts of the processing of the mined coal and iron ore, saturated in heavy metals, are still exposed to erosion in the form of alien spoil tips in the Medves plain, in the area of Zagyvaróna. Due to global warming, the precipitation distribution in Hungary might show a variable trend, so the number of precipitation events with higher intensity may increase, which could have a major impact on the landscape erosion dynamics. The aim of this study was to analyze the dynamic geomorphometric changes of the spoil tip in the area, particularly due to water/precipitation erosion, and to estimate future morphological changes.

In this research, we used digital photogrammetry and geospatial techniques to determine the rate and dynamics of the changes in the spoil tip due to erosion over the studied period. For the time-series analysis, we used scanned, digitalized versions of archived analog aerial photographs obtained from the Lechner Knowledge Centre. The 3D digital point cloud created from the 1976 aerial photographs was compared with the 3D point cloud generated from the images taken in 1988. Subsequently, UAV surveys were carried out in order to record the current state and to study the dynamics of the erosion of the spoil tip over a period of approximately 50 years. To estimate future changes, 10-minute precipitation data from two automatic National Meteorological Service stations (nearest to the study area) were analyzed for the period from 2002 to 2022. The analysis of the areas most exposed to future erosion was performed in ArcGIS Pro.

A comparison of the point clouds showed that the spoil tip lost almost a quarter of its volume during the study period due to erosion activities. Further volume analyses revealed that the volume loss of the slag cone resulting from erosion activities is estimated to be 600

m^3 per year on average. Despite the variable trend in the climate of Hungary, due to the local topography, no significant increase in rainfall intensity is expected in the near future, but the steep morphology of the spoil tip is expected to increase the erosion rate.

Due to increased erosion, more contaminants could be transported to the surrounding soils and groundwater. Continuous monitoring of the future erosion activity and the spread of contaminants will provide a more accurate conclusion on the environmental impact of the spoil tip.

Numerical modelling and mapping of Miocene dyke opening in the Cserhát Hills, Hungary

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Theoretical

The Cserhát Hills are located in mid-North Hungary, at the northern edge of the Pannonian Basin and are parts of the Miocene Inner Carpathian volcanic arc. The Cserhát Hills were strongly influenced by the Miocene volcanism and are built up by polycentric domes, stratovolcanoes, and radial a dyke-system, consistent with their location in an extinct volcanic arc. In the following research we are focusing on this radial dyke-system, which is often segmented and showing changes in their strike-direction. The main strike directions are E-W and N-S, but the dykes with different striking orientation may belong to different volcanic systems and have different ages, respectively. The thickness of the dykes varies between 3 m and 25 m, and the length of the segments varies between 1 km and 5 km. Partial re-mapping of the area was carried out. For studying the stress-field in the area of diking and its evolution, we carry out FEM (finite element method) numerical model of dyke opening by using COMSOL Multiphysics. For mapping the dykes some geophysical methods were tried as well, including multielectrode method and RMT (radio magnetotelluric) measurements.

The extensional structures, which were measured in the bedrock, agree with the stress-fields of previous studies. To expand the previous datasets of the stress field, the cooling joints of the dykes were measured as well. Two sets of cooling joints were identified in the field, one with strike parallel to the dyke, which probably developed during the propagation, and the second is perpendicular to the dyke, which might be the consequences of the dyke intrusion. These data gave a base for the modeling. The aim is to compare numerical models with field observations to shed light on the local and tectonic stress fields, and pressure conditions in the magmatic systems involved. The numerical models provide insight on how large stress was needed to open Cserhát Hills dykes, and if the previous strain field in the area had an influence in this.

Well log categorisation with artificial neural network

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Applied

Hydrocarbon reservoirs can be categorized based on several factors that can be calculated from wellbore measurements. One of these factors is the permeability distribution, which describes the productivity of the reservoir, however, this is not a directly measurable parameter. As a result, one of the main tasks of a well-logging data interpreter is to determine the depth distribution of permeability. Unfortunately, this cannot be calculated using theoretically determined rock physics equations, therefore over the decades, various empirical formulas were determined depending on the lithological setting in which the drilling was accomplished.

These semi-empirical equations only provide an inaccurate estimate of the permeability, as they all include estimated parameters, such as a term describing the amount of irreducible water. Consequently, permeability is still one of the most challenging parameters to evaluate.

Determining permeability through a neural network (NN) is a possibility that allows bypassing rock physics equations and empirical formulas, and can categorize individual reservoirs. This method

requires directly measurable parameters at each depth point, and precise knowledge of the target variable i.e. permeability. The latter is necessary because the NN has to learn the correlation between the measured parameters and the target variable. This procedure is called training. A trained NN can then estimate the target variable.

In my thesis, I investigated the possibility of building a NN that reliably estimates non-measurable parameters such as permeability from measured data. I created two neural networks that can estimate permeability and effective porosity. The networks have been trained on datasets, where the irreducible water was also available, allowing better than the usual estimation of the target variable. Due to the limited amount of available data, the general validity of the NN needs further validation. However, my results show that permeability-based categorization with a NN is feasible. Also, the NN results show better reliability and reproducibility, than those based on semi-empirical formulas.

Relationship between thermal dispersion and heterogeneity of porous media in a synthetic geothermal well doublet

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Theoretical

Geothermal energy is playing an increasingly important role today. Numerical modelling is of an effective support in planning and implementing geothermal systems. In an open system (well doublet), one of the key factors that strongly influences the performance of the system is the thermal breakthrough time, i.e. the time it takes from the injection of the cold water to the appearance in the production. Previous research has shown that the heterogeneity of the medium affects the thermal breakthrough time. In this study, we carried out numerical simulations to investigate the effect of heterogeneity of the porous medium on the breakthrough time in the case of a synthetic well doublet. A two-dimensional finite element model with an area of 500 m x 300 m was built up in COMSOL Multiphysics software including a heterogeneous aquifer with a thickness of 100 m bedded by two homogeneous aquitards. Cold water (50°C) was injected into

the hot aquifer (initial temperature is approx. 120°C) and the time variation of the outlet temperature was calculated for different types and realizations of the heterogeneities. Heterogeneous permeability distribution was created in SGeMS geostatistics software using unconditional Sequential Gaussian Simulation (SGS). The permeability field was characterized by three quantities: the mean (10^{-12} m^2), the variance (one order of magnitude), and the correlation length (R). During the simulation, the scale of heterogeneity, that is the correlation length was varied from R=5 to 50 m, calculating 10–10 realizations for each value of R. The influence of the heterogeneity was quantified by the control parameters (e.g. Darcy flux, outlet temperature). Simulations were performed both without and with the implication of thermal buoyancy.

It was established based on our numerical results that the cold water reaches faster the outflow side, so cooling starts earlier in heterogeneous medium. However, the total cooling is delayed in time compared to the homogeneous model. It was found that the permeability heterogeneity in porous medium induces heat dispersion that can be imitated by using thermal dispersivity in homogeneous medium. A relationship was revealed between the scale of heterogeneity and longitudinal thermal dispersivity (α_L). Accordingly, the heterogeneity scale of R=10 m corresponds to a longitudinal thermal dispersivity of about α_L=7.5 m, while R=20 m can be approximated to α_L=15 m. Although, thermal dispersion is often a neglected or arbitrarily applied parameter (a default value) during the simulation, our numerical model results highlight that the role of the thermal dispersivity is important in the accurate heat transport models. In addition, the thermal dispersivity (the scale of heterogeneity) can be deduced from the outlet temperature time series. In our models, the influence of the thermal buoyancy seems negligible, however decreasing the injection flux or considering 3D flow pattern, its role might be more significant.

A robust clustering technique assisted interval inversion of well-logging data for automatic determination of formation boundaries

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Theoretical

Machine learning methods are widely used for overcoming the weaknesses of traditional (linearized) inversion methods. This research study proposes a workflow in which a robust cluster analysis method is integrated with the so-called interval inversion method. This workflow treats the formations boundaries coordinates as unknown and estimated automatically during the inversion procedure. The clustering method is used for overcoming the problem of inversion related to the determination of formation boundaries. The feasibility of the proposed workflow is tested using synthetic data and field data, respectively. The robust clustering method uses the Most Frequent Value technique for calculating the weights of the calculated distance metric as similarity criterion. A statistical study is shown to demonstrate the robustness of the MFV-based clustering method compared to conventional k-means clustering. The interval inversion is used to reduce the data noises by increasing the overdetermination ratio, which inverts all data of a predefined interval simultaneously to estimate petrophysical parameters. A series expansion-based discretization technique uses the Legendre polynomials as a basis function to discretize the petrophysical parameters along the well. The proposed inversion procedure is extended to predicting the resistivity of shale as a zone parameter that has a fixed value within the same interval. The automated inversion procedure is applied to the hydrogeological borehole dataset of the Baktalórátháza-1 well in Northeast Hungary. The well logging data show a response of the shaly sand sequence. The upper 80-100 m of the well was drilled into Pleistocene strata built up predominantly by sands, with limited grain size change discernible by geoelectric techniques. According to borehole logs, the underlying rock of the sandy succession was shale. Sands of 100-160 m thickness had been deposited, followed by a shaly formation and 5-15 m thick coarse-grained beds. At a depth of 240 m, the border between the Pleistocene and Pannonian periods was

detected. Clayey sand, gravel, clayey silt, clayey marl, and bituminous made up most of the Pannonian shaly complex. Finally, the MFV clustering method could separate between different formations and gives an initial estimation for layer thicknesses. During the interval inversion phase, the petrophysical parameters and some zone parameters can be optimized simultaneously.

2ND SESSION

Estimation of the parameters of a lunar ellipsoid of revolution based on GRAIL selenoid data and Fibonacci mesh

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Theoretical

Because the Moon is much less flattened than the Earth, most lunar GIS applications use a spherical datum. However, nowadays, with the renaissance of lunar missions approaching, it seems worthwhile to define an ellipsoid of revolution that better fits the lunar gravity potential surface. The main long-term benefit of this might be to make the lunar adaptation of methods already implemented in terrestrial GNSS, gravimetry and GPS applications easier and somewhat more accurate.

In my work, I used a 660th degree and order potential surface called GRGM 1200A Lunar Geoid, developed in the frame of the GRAIL project. Samples were taken from the potential surface along a mesh that represents equal area pieces of the surface. The method of point grid selection was provided by a relatively simple Fibonacci sphere. I tried Fibonacci spheres with 100, 1000, 3000, 5000, 10000 and 100000 points and also separately examined the effect of rotating the network by length for a given number of points on the estimated parameters, but these differences were only noticeable for the lower resolution networks.

I estimated the best-fitting rotation ellipsoid semi-major axis and flatness data for the selenoid undulation values at the network points, which were obtained for a=1,737,576.6 m and f=0.000305. This

parameter pair is already obtained for a 10000 point grid, while the case of reducing the points of the equidistant grid to 3000 does not cause a deviation in the axis data of more than 10 centimetres. As expected, the absolute value of the selenoid undulations has decreased compared to the values taken with respect to the spherical basal surface, with maxima exceeding +400 m still being found for Mare Serenitatis and Mare Imbrium, and the largest negative values for South Pole Aitken and Mare Orientale.

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Modern inversion tools for evaluating unconventional hydrocarbon reservoirs

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Theoretical

Exploration and exploitation of unconventional hydrocarbon reservoirs have become in the last years an important topic for the oil and gas industry since the increase in energy demand worldwide has been growing dramatically as conventional resources supplies diminish or become unavailable to the hydrocarbon industry. Due to this, the development of new and more robust methods to evaluate the hydrocarbon potential, estimate hydrocarbon in place, and the producibility of reservoirs are turning out to be of the utmost importance to overcome the limited data availability of cores, wireline logs, seismic data, geochemistry, and other relevant geological studies.

This research focuses on the development of advanced well-logging data processing techniques for a more accurate, reliable, and robust evaluation of unconventional hydrocarbon reservoirs since standard used quick-look methods have shown not to be the most optimal for this task due to the complex multimineral nature of organic-rich reservoirs. For instance, the number of the petrophysical properties and fractional volumes of matrix components may exceed that of the observed wireline log types, therefore conventional inversion

techniques for estimating petrophysical parameters tends to lead to low data-to-unknowns ratio and consequently are very sensitive to data noises.

For that reason, to assure a very stable inversion procedure and make it possible to estimate several petrophysical parameters of unconventional hydrocarbon reservoirs, it is proposed to work on a larger data-to-unknowns ratio of the inverse problem and consider zone parameters estimation that is sensitive enough to the observed well logs and can be estimated by inversion with high accuracy and reliability, avoiding arbitrary selecting them as constants that are chosen from theoretical data or laboratory samples.

Moreover, a critical indicator of hydrocarbon resource to be studied is the total organic carbon (TOC), which is very important when evaluating potential organic shales-gas reservoir; it expresses the amount of organic carbon present in the formation, and it has been shown a direct relationship with porosity and gas saturation. Although diverse well-log interpretation methods have been developed to assess TOC estimation, we have tried to improve the valuation using a modern statistical approach (i.e. factor analysis) and considering the optimization of the estimation of the level of organic maturity (LOM), since some TOC estimation methods are function dependent of it (e.g. Passey method).

Investigating the agricultural applicability of interferometric coherence

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Applied

Monitoring of agricultural land by Earth-orbiting satellites nowadays is a principal tool to study the evaluation of vegetation, detect farming activities and help farmers in their decision-making. In this context the Sentinel-1 mission with C-band synthetic aperture radar (SAR) sensors have been making a significant contribution to this kind of investigation since 2014. Based on these SAR images, the interferometric coherence can be calculated, which is the correlation of the phase values of electromagnetic waves, and it is useful to detect

changes on the surfaces. This parameter has been investigated before, but its agricultural applications and limitations are not completely known. Therefore the study aims to get an overall picture of the applicability of interferometric coherence.

A one-year time series of Sentinel-1 images were analysed over a complex agricultural area (eight crop species) in the border counties of Pest and Heves. For this study the year 2018 was chosen since this period provided the lowest available temporal resolution with an almost complete 6-day revisit time, which is necessary to track the detection of changes as accurately as possible. Due to the dual polarization mode of the SAR instruments, the contribution of the two channels (VV and VH) was also observed.

The obtained time series have confirmed that the evaluation of the coherence values for both channels is related to the growing cycle of each crop type, which allows for partially delineating the period of sowing, growing, and harvesting. In this work, these results were compared with the most commonly used SAR product, the backscatter coefficient (sigma0) values, but they show a different trend over time. The potential use of interferometric coherence as an input feature for crop classification is also investigated. Using a popular supervised machine learning algorithm, namely Random Forest classification, it was found that the coherence data do not provide a notable accuracy of classification when used individually (overall accuracy is around 60%), while sigma0 data provide accuracy above 80%. Furthermore, it is shown that using the coherence data of the VV polarization as input yields slightly better results than using the VH channel. In contrast, for sigma0 VH performs better than VV. Finally, when coherence and backscattering coefficient are jointly analysed with both polarimetric channels, the best accuracy can be achieved (88.1%).

Cases study of Petrophysical rock typing and Permeability prediction

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Applied

Permeability prediction is a crucial step in the assessment of rock quality. The knowledge of the relation between the different

geological characteristics and petrophysical behaviour can be used for dividing the whole rock units into several intervals different in permeability values. Understanding the relationship between sedimentological features and physical parameters of rocks such as porosity, permeability, grain density, and bulk density, is essential for accurate rock characterization. This study shows some modern procedures (factor analysis and cluster analysis) for quantifying permeability. The proposed study was carried out on two field datasets from different geological provenance in Egypt. To gain knowledge of the information obtained during petrophysical measurements, statistical approach calculations must be created for identifying the number of different rock units. In general, both petrophysical analysis and statistical calculations are very rich in information but there is currently no exact relation between physical parameters such as porosity and permeability to improve the data obtained from the measurements. The first case study focuses on petrophysical analyses of 51 surface plug samples of the Palaeozoic Nubia sandstone rocks, which are presented by five rock units. Petrographically examination was carried out for thin sections proving the presence of diagenetic processes such as dissolution as well as iron cementation. While the second case study includes conventional core analysis results of a tight sand reservoir of the Jurassic layer. The sedimentological investigation and the petrophysical measurements show that there was evidence of clay-filling pores. Although factor analysis results have been compared with cluster analysis results and this study shows that factor analysis-based clustering can identify clusters that may not be immediately apparent based on the raw data. It can also identify clusters that are based on complex relationships among multiple variables, rather than just a single variable. Finally, the permeability resulting from the HFU model shows an excellent fitting with the measured permeability, while the cluster permeability shows a lower correlation but is higher than that of the FA-based cluster. The FA-based cluster analysis can extract hidden trends from the porosity permeability relationships.

Using electrical borehole image logs in hydrocarbon reservoir parametrization of thin bedded, laminated shaly sandstones

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Applied

Vertical resolution of standard wireline logging tools like gamma ray, density, neutron, acoustic, laterolog and induction resistivity, varies between ca. 0.2-0.8 m. For a thin bedded shaly sandstone, layers can alternate in the order of several millimeters. It is easy to see, that this is a huge scale difference, which can lead to significant uncertainties in log interpretation.

If the sand-shale transition is not sharp, but rather continuous, the tools will mix up the log responses, possibly resulting in lower porosity and hydrocarbon saturation values. Effective thickness on the other hand can be both over- or underestimated in thin bedded reservoirs, because shale volume cutoff will miss the smeared thin laminaes, and depending on the dominance of sand or shale respectively, thickness will be higher or lower than the realistic value.

As usually the target reservoirs are sand dominated, the two effects (lowered POR and SHC, and increased Net thickness) can roughly equal each other, thus the total hydrocarbon volume computed from conventional log interpretation might be acceptable. But still, the permeability of the reservoir is expected to be higher than the computed one, because permeability calculations are generally based on the (underestimated) porosity values. Not to mention the shale dominated cases, where every parameter is worsened, if they are detected at all by cutoffs.

In the oil&gas industry there are two different ways to resolve thin bed analysis: 1 – improve the vertical resolution of standard logs by software, using inversion (like Schlumberger's SHARP, or Halliburton's LARA), or 2 – measuring vertical and horizontal resistivity (e.g. 3DeX by Baker Hughes, MCIT by Halliburton or RtScanner by Schlumberger), which provides more accurate evaluation of water saturation in anisotropic formations, including turbidites, laminated formations or low-resistivity pay, without the need for exact layer distinction.

In this project, I have tried to involve electrical borehole images in reservoir parametrization, based on the fact, that they have a ca. 0.5 cm vertical resolution, which is appropriate to distinguish thin layers. This type of measurement is quite common in MOL's logging program in hydrocarbon reservoirs due to its added values for example in fracture analysis and sedimentology. In thin bedded, laminated shaly sandstone reservoirs, electrical images are primarily used qualitatively, to specify perforation intervals by identifying reservoir boundaries, or occasionally water phase contacts. But on top of this, the measured conductivities can also be used quantitatively by clustering, so we can set a high-resolution volume estimation for shale, sand, or even tight carbonates (which is a common feature in our case studies).

Based on this lithology, I have calculated porosities from regional trend curves, originating from core measurements of nearby analog wells. For water saturation computation I used the image-derived resistivities normalized by a deep reading resistivity curve, because electric images have a quite shallow depth of investigation, thus measure the invaded zone.

In the case studies, presented in this material, the expected net pay thickness of targeted sandstones were 5-10 meters. Evidentially, the presence of thin lamination here can have a significant impact on hydrocarbon volumes, and therefore on the economics of the well. By using the electrical borehole image logs in reservoir parametrization, we can decrease the uncertainties of conventional log interpretation and have a more detailed description of the system.

Trace element and isotope signatures of sulfides from all mineralized zones of a porphyry-skarn-epithermal system

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Theoretical

LA-ICP-MS was used to determine S and Pb isotopic compositions, as well as trace element concentrations in sulfides from the deep porphyry, skarn, carbonate-replacement (CR), and shallow HS and IS epithermal mineralization at the Recsk ore complex (NE-Hungary) of

Oligocene age. Au, Tl, Hg, W, Ba contents of pyrite from the epithermal zones are highly variable and two orders of magnitude higher than in the ore types at depth. Redox sensitive elements (Mn, Mo, Sn) together with Re show slightly enriched character in pyrite from skarn compared to other ore types. Se/Te and Co/Ni ratios can be used to approximately distinguish the major ore forming environments, through that some of the ore types too. Chalcopyrite from the porphyry-copper ore is distinct from other mineralized zones by elevated In, Cd, Zn concentrations whereas it is enriched in Se, Ag, Sn, Pb, Bi in the epithermal zones. Pb isotope data from galena (n=24) show narrow ranges of $^{206/204}$Pb (18.9383-18.8451), $^{207/204}$Pb (15.7427-15.6881) and $^{208/204}$Pb (38.9416-39.0521) in the skarn, CR and HS ores. δS^{34} values in pyrite from porphyry (n=60) (1.9 ± 1.4‰), skarn (n=42) (2.9± 1.2‰) and CR (n=46) (3.5 ± 1.7‰) show the evolution and mixing of the mineralizing fluids from the porphyry ore towards the sedimentary host rocks with some extremely fractionated values (-14.7 ± 0.6 ‰) in skarn, most probably caused by the occurrence of anhydrite. Sulfur isotope data from sulfides in the HS (n=38) (1.0 ± 2,8‰) and IS (n=37) (2.4 ± 1,6‰) epithermal zones show multimodal distribution probably due to rapidly changing redox conditions. Results of our research indicate that sulfide trace element and isotope signatures in porphyry-skarn-replacement-epithermal ore complexes can possibly be used for fingerprinting mineralization styles and producing vectors for mineral exploration.

POSTER SESSION

PCA-based soil geochemical investigation of precious metals in Rudabánya, Hungary: Uncovering the hidden relationships

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Poster

Rudabánya is considered one of Hungary's valuable complex ore occurrences due to its historical record of mining activities. Base

metal discoveries started decades ago with the exploration of Cu and Pb enrichments at what was once a mine for iron ore. It was also known that silver and gold anomalies exist within the ore zone. All previous studies have been interested in iron ore and base metals, with only a few mentioning the presence of gold or silver. Many sampling programs produced data with variable sampling, assaying, detection, and precision parameters during the past four decades, showing that the gold has some drill intersections in the oxidation zone and in the footwall sandstones. The current study explores the possible association between gold and silver and the spatial patterns of such associations in the soil of Rudabánya geochemically based on principal component analysis (PCA) as a first step in investigating the gold and silver in the study area. In the geochemical prospecting of precious metals, grouping the elements is beneficial, in particular for Au and Ag due to their direct relationship and the occurrence of Au-Ag solid solutions. PCA is an appropriate method for discovering clusters of correlated features where it is a highly effective approach to be considered in preliminary evaluations where fewer variables are acquired, there is less information loss, and visualization becomes significantly more meaningful. PCA was implemented on 15 and 12 selected elements from two sampling zones respectively, in order to obtain a multi-element geochemical signature. In the first soil sampling area, the first four PCs (PC1, PC2, PC3, and PC4) comprise the most variance of the selected elements, where Au shows uncorrelation in all PC plots while Ag shows a strong correlation with Sb, Pb, Hg, As, Zn, and Cd. In the second soil sampling area, the first three PCs (PC1, PC2, and PC3) comprise the most variance of the selected elements, where Au shows uncorrelation in all PC plots, while Ag shows a strong correlation with Ba and S. PCA reveals that there is no association between gold and silver in both sampling zones, indicating that they might come from different sources of enrichment. The proposed method gives a better understanding of the Au-Ag relationship, the complex geochemical signatures of mineral deposits, and an initial glance into the nature of their existence in Rudabánya.

Evolution and relation of Black Belly tuff-cone, North-Tanzania

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Poster

The East African Rift System contains several volcanoes with diverse rock types and heterogeneous compositions. One of its most extended volcanic areas is the Crater Highlands in Tanzania, built by various basaltic volcanoes (Mollel, 2007). In addition to common basalt, unique rock types also occur in the North Tanzanian Volcanic Province, such as the natrocarbonatite of Oldoinyo Lengai. Alongside the basaltic and carbonatite-producing volcanoes, many parasitic cones occur across the entire volcanic province. One such cone is Black Belly, a flat tuff ring located northwest of Oldoinyo Lengai (Keller et al., 2006). The current study focuses on the relation between Crater Highlands, Oldoinyo Lengai and the Black Belly area – previously believed as the Oldoinyo Lengai's parasite cone (Keller et al., 2006).

Numerous volcanic rock samples were collected from the Black Belly tuff cone field (coordinates: -2.623254, 35.904846). Parts of these samples are already examined by us, but this year we extended the research to other samples as well.

Petrographically, the studied Black Belly samples are alkaline basalts with a microcrystalline groundmass and phenocrysts. The groundmass consists of plagioclase, clinopyroxene, Ti-magnetite, and apatite, and the phenocrysts are predominantly clinopyroxene, altered (to calcite and serpentinite) olivine, and carbonate minerals.

While Oldoinyo Lengai and Black Belly rocks are not similar or directly related, the mineralogy and mineral chemistry of the studied Black Belly samples are similar to those representing the Crater Highlands' volcanoes. Based on their compositions, the Black Belly clinopyroxenes define one end-member, and Oldoinyo Lengai clinopyroxenes represent the other end-member, while the Crater Highlands' samples are of a transitional composition. The compositions of the other minerals (olivine, feldspar, and magnetite) confirm this theory.

According to mineral chemical data, the Black Belly samples crystallized in several steps under high pressures (5.6–6.6 kbar) and temperatures (750°C–900°C) from an alkali basaltic melt.

Considering the new chemical and thermobarometry mineral data presented in our study; and the structural evolution of the region, Black Belly cannot be petrologically part of Oldoinyo Lengai. Instead, it defines an end-member of a series, with Oldoinyo Lengai representing the other extreme and the Crater Highlands volcanoes in a transitional position.

Background effects and suppression in muographic measurements

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Poster

Muography is a quickly developing field of research that utilises high energy cosmic muon particles for imaging and determining the density distribution inside large objects, such as volcanoes and pyramids. Data is acquired by detecting the trajectory of muons that pass through the observed body. Our Group in Wigner RCP is involved in R&D of gaseous particle detectors, especially for muographic applications, via portable multi-layered tracking systems. Muographic imaging requires nice reconstructed differential muon counts, while the imaging suffers from natural background. Underground sites have high natural radioactivity, while surface-based muography experiences high background from backscattered and low-energy particles. The poster details the suppression power of multi-layered trackers, via case studies of the former effects on real measurement, in ore-mine and volcano-muography.

Data analysis of the MTOA-02 base magnetotelluric section

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Poster

Magnetotellurics is a passive exploration technique based on the registration of the Earth’s natural electric and magnetic field

variations. Its major sources are the location and time dependent fluctuations in the Earth's magnetic field – which create long-period signals – caused by the solar wind, as well as the meteorological activities (e.g. thunderstorm activities) which are responsible for the formation of short-period signals. The signal propagates through the subsurface medium by induction and is able to carry information about the distribution of the electrical properties of rocks from a few 100 meters up to a depth of 10 to several 100 kilometers. Thus the method is suitable to use in geological research.

My work concerns the processing of a NW-SE oriented base magnetotelluric section (MTOA-02, direction: Zsíra–Badacsony–Buzsák–Sellye) which was created from archived data in the Transdanubian region. In the current stage of my work I'm preparing the curves from field measurements for further processing steps and inversion. Useful information about the local geological setting can be obtained from these investigations.

The impedance tensor elements – which were created from the recorded time series data – are stored in the so-called .EDI files. The apparent resistivity and the phase can be calculated from these. Filtering and different analysis techniques were applied on the raw data with the help of the MTpy python library [1][2]. Outlier data points can be identified by plotting the unfiltered data as a function of period. From the different behaviour and the splitting of the TM and TE curves the presence of anisotropy can be inferred that can be related to magnetic objects [3] or tectonic elements. After applying Bostick's frequency-depth transformation [4], apparent resistivity-depth curves can be created which emphasize the mentioned phenomena even more. The apparent resistivity-depth curves were compared with the estimated resistivity profiles obtained from the Bostick transformation and its approximation formula according to Weidelt [5]. The main regional geoelectric strike directions along the section were examined by geoelectric strike analysis. This information can be used to rotate the data into the direction of electric and magnetic polarizations. The dimensionality of the space below given measurement points was examined by phase tensors and other quantities characterizing dimensionality.

Information gained from these processing steps contributes to a general overview of the area and prepare the data for further processing.

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Deep CO_2-rich gas emanation in the Southeastern Carpathians

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Poster

A multidisciplinary geological-geochemical-geophysical approach within the framework of the of the Topo Transylvanian project has been initiated in the city of Covasna (Kovászna) to understand the genetics of the local non-magmatic, deep-origin gas emanations at the internal part of SE Carpathians. In our study, we investigated the origin of H_2O, CO_2 and He of gas-rich mineral water springs located

in the centre and vicinity of Covasna town. From these locations we measured the $\delta^{2}H$, $\delta^{18}O$ stable isotopic ratio of the sampled spring waters and the $^{3}He/^{4}He$ and $\delta^{13}C$ stable isotopic ratio of the emanating helium and CO_2, respectively, dissolved in the same spring waters. Based on the stable isotopic ratio results, the spring waters and the majority of the gasses originate from a metamorphic source. The metamorphic signal of the upwelling H_2O can be overwritten by the local groundwater flow and, thus, the preservation of the deep signal is topographically controlled. In addition, the elevated helium (R/Ra) stable isotopic ratios suggest the contribution of an upper mantle source component.

We propose that beneath the Southeastern Carpathian bend area, mantle fluids originate from the dehydration of the sinking Vrancea slab or from the associated local asthenospheric upwelling. The flux of the mantle fluids is enhanced by lithosphere-scale weakening zones that also support the inflow from the upper mantle into the lower crust. Mantle fluids may shift the composition of pore fluids consequently inducing crustal decarbonization and devolatilization by metamorphic reactions in the lower and middle crust. A multistage evolution for the fluid generation and migration is assumed based on the local geotherm and the p-T-X(CO_2) conditions of calc-silicates. We infer that deep-source fluids may play a more important role than temperature in the generation of crustal fluids in deep-seated deformation zones. In the upper crust, deep-origin fluids are dispersed toward the surface along faults resulting in gas-rich springs many of them located along the basin boundaries as observed for the eastern Targu Secuiesc Basin where Covasna is located. Our observations in the Southeastern Carpathian bend area show a strong similarity to other deep-seated deformation zones worldwide (e.g., Himalayas, Alps, San Andreas Fault) making it a good natural example to understand the connection between the deep sources of gas emanations, deep-seated deformation zones, and surface-emerging gas-rich springs.

Preliminary results of numerical modelling and time series analysis to quantify the neglected groundwater component in Lake Velence's water budget

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Applied

Lake Velence is a popular tourist destination in Hungary; thus, the lake is the focus of continuous interest and is constantly examined regarding water quality and quantity. In recent years, the lake's water level has shown a severely deteriorating tendency, possibly caused by climate change. Since the lake's existence is threatened, it has become necessary to properly assess the quantity of water flowing into and out of the lake.

Given the lake's properties (extent of the catchment area, number of surface inflows, regulation etc.), its main water input comes from precipitation, and its main output is evaporation. However, the groundwater component could also be important from a water management point of view since groundwater can represent a significant buffer against climate change. Until recently, the interconnection between groundwater and the lake has not been investigated in depth. However, recent research revealed that the lake could be the discharge point of local flow systems.

The presented study aimed to support further that Lake Velence and the groundwater are connected resources and to quantify the groundwater inflow. To achieve this aim, we created a regional-scale transient 3D numerical groundwater flow model for the lake's catchment area using Visual MODFLOW. The time series of weather parameters (i.e. the amount of precipitation, calculated evaporation, air temperature), the discharge rate of surface water courses, and groundwater extraction data from 1990-2021 have been incorporated into the model. Furthermore, we used the time series of monitoring wells of unconfined and confined aquifers to calibrate the model. The mentioned time series were also analysed using statistical methods, and the relationship between rainfall, the groundwater level measured in wells, and the lake level were looked into in detail.

Our findings complemented the results of the previous studies on the lake's catchment area that there is a not insignificant connection between the lake and groundwater. Furthermore, the modelling results support that the lake is fed by local flow systems with shallow penetration depth and relatively short residence time, which are known to be more sensitive to climate change.

This research was supported by the ÚNKP-22-3 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund. In addition, the research was funded by the National Multidisciplinary Laboratory for Climate Change, RRF-2.3.1-21-2022-00014 project.

Energy storage in hydrogen, hydrogen storage in porous rocks

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Theoretical

One of the main challenges of our society is to shift the energy mix from fossil fuel based to a more carbon-dioxide neutral one in which renewable energy takes a prominent role. This so-called energy transition is not new, in the past remarkable shifts were made (e.g., coal to oil in the 20th century). However, it is not only limited to the gradual closure of fossil energy carrier production, but it is a paradigm shift that has an influence on the entire energy system including production, transport, and storage. Hydrogen (H2) is an attractive energy carrier as it is capable of balancing weather dependent energy production. Thus, in July 2020, “A hydrogen strategy for a climate-neutral Europe” was published that is mainly based on the power to gas concept (P2G), which concerns electric energy conversion to hydrogen through water electrolysis. The obtained gas can then be stored and reconverted into electricity when needed. The largest storage and discharge capacities are provided by porous geological formations, including depleted gas fields, which feature a porous and permeable reservoir formation, a caprock and a trap structure.

In this work, we study the chemical (i.e., mineral geochemical interactions) issues related to injection of hydrogen into depleted gas reservoirs based on specialized experiments and geochemical

modeling (in Phreeqc ver.3). Our main aim is to assess and demonstrate if and how hydrogen may be safely stored in depleted hydrocarbon reservoirs in the Pannonian Basin, without adverse industrial or technical difficulties. The experiments are designed to detect mineral-H2 reactions one by one. We present results about the main rock-forming minerals, which are presumably sensitive to H2 environment and as a result, dissolution or precipitation are expected.

The final outcome of the project will be assessments of techno-economic feasibility of implementing hydrogen storage in preferred locations, to enable scientific evidence-based decision making on pilot demonstration and industrial deployment.

The study has been financially supported by O&GD Central Ltd. as well as providing well data, cuttings, and core samples. This work was prepared with the professional support of the Doctoral Student Scholarship Program of the Co-operative Doctoral Program of the Ministry of Innovation and Technology financed from the National Research, Development and Innovation Fund.

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Permian-Triassic red sandstones from the Balaton Highlands and the Mecsek Mountains. Comparative micromineralogical and geochemical study

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Poster

Studies in provenience have been mainly performed according to classic sandstone petrography and heavy mineral analysis (HMA) from thin sections or some cases examination of separated heavy (>2,85 g/cm^3) minerals. At present several methods are in common usage to deduce parameters (source rock lithology, climate, weathering, transport, geotectonic setting) connected provenience studies, such as petrographic analysis on sandstone framework and the components ratios (volumetric point counting data). During the last two decades the use of whole-rock geochemical data for provenience has experienced an important development.

There are two important territories where red coloured sandstone series appeare on the surface in the Carpathian-Pannonian region. One in the Balaton Highlands, the “Balaton-felvidék Sandstone Formation” and the other is in the Mecsek Mountains: where the older one is the Kővágószőlős-, the younger one is the Jakabhegy Sandstone Formation. These sandstones were the most appropriate for making different types of stone tools, such as ground stones (e.g. mortars, sharpening stone, mill stone), different moulds and/or building stones. The analysis of the red coloured sandstones from the different geological occurrences is a very important task. Our aim is to compare the source materials with the tools made of similar rocks from different archaeological sites, such as Lánycsók, Paks-Gyapa and Palotabozsok.

A total of 24 sandstone samples were collected for petrographic (macro- and micro) analysis from different geological outcrops. We chose 6-6 samples from the two main terrains for the heavy mineral and the whole-rock geochemical analysis. During the thin section analysis, we examined the grains, the cement, the framework, the porosity, and the heavy mineral content of the samples and then we identified the ratio of the main components with the use of a volumetric point counting method. Framework composition of the samples from the Kővágószőlős Sandstone Formation is arkose (mean $Qt_{60}Ft_{24}Lt_{11}$; Qt-total quartz; Ft-total feldspar; Lt-total lithics) and from the Jakabhegy Sandstone Formation is subarkose-sublitharenite (mean $Qt_{77}Ft_{13}Lt_{9}$; Qt-total quartz; Ft-total feldspar; Lt-total lithics). These sandstones have very similar composition: 1a) The samples of the Kővágószőlős Formation are well or medium sorted and the quartz grains are weakly rounded. The content of feldspar is varying. Lithic rock fragments are common and consist mainly felsic and intermedier volcanites and plutonic clasts. Syntaxial quartz overgrowth is very scarce. 1b) While the samples from the Jakabhegy Formation show evidence of maturation during transport (well sorted and high values of quartz grain roundness) and recycling of volcanites in the Variscan basement. Lithic rock fragments consist of mainly felsic volcanic- and a few plutonic clasts, feldspar is mainly orthoclase and/or sanidine (rarely microcline). Syntaxial quartz overgrowth is the main interstitial cement. 2) The samples from the Balaton-felvidék Sandstone Formation are litharenites (mean $Qt_{55}Ft_{1}Lt_{42}$; Qt-total

quartz; Ft-total feldspar; Lt-total lithics). These sandstones consist a lot of felsic and less mafic clasts, moreover low-grade metamorphites.

We separated the heavy minerals and identified them by optical and scanning electron microscope (SEM-EDX) methods, moreover we determinate mineral-chemistry of the grains. Heavy mineral content and the spread of the tourmaline mineral chemistry data differ from the two main territory. However, these differences are not correlate with the colours of these minerals. The whole-rock geochemistry (NAA and PGAA) also varying and show little differences (e.g. La/Sc-Cr/Th, Sc/Th-La/Th) within the samples from the Balaton Highlands (two groups can be separated). The geochemical composition of the samples from the Jakabhegy- and Kővágószőlős sandstone Formations are very similar and differ from the those from the Balaton Highland. These last ones contain mafic elements such as Cr or Co.

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Supply-induced transgression in endorheic lakes: a fundamental difference between lacustrine and marine settings

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Poster

Palaeo-lakes are important climate proxies, and they host a large portion of the world's geo-resources, including fresh-water reserves, therefore understanding lacustrine basin fill pattern is crucial. Like in marine systems, the depositional architecture is determined by water-level variations. However, in hydrologically closed – endorheic – lacustrine settings, where the water-level is disconnected from the seas, instead of eustasy, water balance is mostly driven by climatic forces, such as the interplay between precipitation and evaporation. Commonly local structural movements are also regarded as important controls on evolution of lake-level. This study emphasizes the main differences between marine and lake systems and the possible pitfalls of working in endorheic settings.

To better understand the different driving mechanisms on water-level changes, a diffusion-based numerical modelling tool, DionisosFlow has been applied. A series of source to sink models with an area of 800x400 km has been conducted to analyse the effect of climatic variations, subsidence, compaction, and sedimentation in large, deep, supply-dominated lake basins. These lacustrine models are compared to their marine counterparts. These conceptual models are constrained by seismic-scale observations from the Late Miocene Lake Pannon, a large, enclosed, long-lived water body.

In the models the lacustrine system responds rapidly to any perturbation in evaporation and precipitation. The lake-level is controlled by the extension of the steady-state lake surface and the dip angle of the shore. Our models infer that variable subsidence rates have limited effect on the equilibrium lake surface; therefore, water-level is principally governed by climate. When applying fluvial sediment input, deposition takes place from deltas, through shelf-margin wedge to the deep basin. A long-term water-level rise occurs in correlation with the increasing area of the coastal plain due to the basinward shift of the shoreline. This results in an overall aggradational stratigraphic architecture. In contrast to marine systems, where sedimentation does not influence relative sea-level, lake-level rise is induced by normal regression driven by sediment supply.

The study is part of the NRDI/NKFI project no. 143787.

Hilbert transformation using Chebyshev polynomials with IRLS

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Applied

Noise is always present in geophysical measurements, so it is crucial for the methods used to process these data to be sensitive to it. Geophysicists often encounter regular noise in their data that can obscure their observations, which has been a persistent problem for them to address. For this purpose, we introduced a new robust inversion method based on Chebyshev polynomials and Iteratively Reweighted Least Squares (IRLS) method for calculating Hilbert transform. The resistance of the robust Fourier transform process (IRLS-FT) to outliers and its outstanding noise suppression capability

justify the method being tried in the field of seismic data processing. As the first stage, we present the production of the Hilbert transform based on a robust inversion, and as an application example we calculate the absolute value of the analytical signal that can be produced as an attribute gauge (instantaneous amplitude). The new algorithm is based on a dual inversion: we determine the Fourier spectrum of the time signal (channel) by inversion, and the spectrum obtained by the transformation required for the Hilbert transform is transformed into the time range with a robust inversion. The latter operation is carried out using the Steiner weights calculated using the IRLS method (robust inverse Fourier transform based on inversion). To discretize the spectrum of the time signal, we use the scaled Chebyshev polynomials in a series expansion. The expansion coefficients are the unknowns in the inversion. The new Hilbert transform procedure was tested on a Ricker wavelet loaded with Cauchy and Gaussian post-distribution noise. The results show that the procedure has remarkable resistance to outlier noises and noise suppression an order of magnitude better than that calculated by the conventional (DFT-based) method.

Economic potentiality of heavy mineral sands in the Pannonian Basin – A case study

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Poster

Most of the Upper Miocene and younger sands in the Pannonian Basin are mined for the construction industry; however, these sand deposits contain numerous heavy minerals, which has not been utilized so far. Therefore the secondary mineral-mining would be able to counterweight the ever-growing import needs.

In this case study I present, how the most important placer heavy minerals (gold, rutile, ilmenite, zircon, monazite, xenotime, allanite) appear in the young sand: appearance, percentage and the critical elements they contain.

Considering the direction of the research, industrial methods are the most preferable for the separation of the aforementioned minerals,

such as magnetic (ilmenite and rare earth minerals), electrostatic (rutile) and gravitational (zircon) [1] [2]. For the very small sized minerals, flotation is the recommended method (in the case of monazite) [3]. During this preliminary research, sodium polytungstate solution was used to separate the heavy minerals, and scanning electron microscopy for the determination of their critical elements concentration.

From the acquired information about the average concentration of the critical elements, it is possible to estimate the formation's reserves. This work will also present these estimations, both to the entire volume of the sand and to the heavy mineral fraction.

For this case study, we sampled the Győr III (Győrszentiván, Tibori) sand mine. It belongs to the Pannonian Zagyva Formation, which unit is the youngest non-terrace material of the Győr Basin [4]. The researched material here is the caprock of a Unionidae-containing pelite: a 15-20 m thick, limonite cemented cross-bedded fine to medium-grained sand. During this study, it became clear that this sand is a "worst case scenario" in terms of raw material research: the heavy mineral content in the separated grain size zone (63-250 μm) was only 1.5%. The average roundness of the grains was low; the searched minerals' maximum amount was 4% of the heavy minerals. The novelty of the research is the first confirmed occurrence of glaucophane in the Győr Basin sands.

The heavy minerals of the Zagyva Formation in the studied sandpit are from a nearby area of provenance, based on the weak roundness. Most of the determined heavy minerals indicate low- to medium metamorphic grade rocks in the source area. The only exceptions are the pyroxenes, which are either high-grade metamorphic or volcanic by origin. The small number of well-rounded zircons indicates secondary erosion of an older sandstone, or, considering the metamorphic source rocks of the other heavy minerals, metasandstone. Due to the short sediment transport and the fast burial, there was no time for placer deposit forming. Though our investigation extends to only one locality, we believe that the Zagyva Formation is unsuitable for the secondary mineral mining.

The example presented might be a worst-case scenario, but the described methods can be used to determine the theoretical amount of the heavy mineral potential for secondary raw material mining in sand

beds – if the area of provenance and the movement distance of the grains are known.

This work could not have been made without the courtesy of Glázer Transz Kft. and the help of Dóra Georgina Miklós, Péter Janka, Dániel Rezes and Máté Biró.

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Environmental history of Lake Kolon based on sedimentological analysis

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Poster

The wetlands, peatlands, mires and bogs not only carry information about their environment but also reveal geological and cultural history facts after their formation. Our most important goal of the study is to get to know the formation and transformation of the lake and bog phases and the development of the enviroment at the end of the Quaternary.

We were curious about the development phases of Lake Kolon, so we conducted and loss on ignition analysis to obtain organic, inorganic and carbonate matter content, and grain size and magnetic susceptibility analysis. With this data, and the help of the Troels-Smith and bottom lake deposit classification, we were able to distinguish the lake and bog phases and found that lacustrine clay, consisting of nonorganic matter (440-280 cm), served as the base and bottom for the lake. The lake phase with a slow clay gyttja sediment development started around 17700 BP (280 cm). This is followed by

an increase in carbonates and a calcareous lacustrine sediment phase (220-172 cm). The peat accumulation started at the Greenlandian boundary, about 11700 years ago, with a smaller (170-122 cm) and a larger (120-38) peatland phase. Due to the human presence from the Mediaeval Ages, the peat accumulation changed and clay gyttja sediment formed on the top of the sequence (36-0 cm).

Defining strarigraphic units for regional hydrogeological model

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Poster

When establishing a geological model of an area, the separation of stratigraphic units bounded by quasi-isochronous surfaces are in the focus of the analysis, however the hydrogeological understanding requires the tracing of hydrostratigraphic units. These hydrostratigrapic units are the combination of the lithologic and hydrogeological parameters of the geological formations, considering the porosity, hydraulic conductivity and specific storage (Leaf, 2012, Bledsoe et al., 1990). Thus, for defining the geologically-hydrologically relevant hydrostratigraphic units (Maxey, 1964) we have to identify spatial correlation between porosity, permeability guided by the previously created geological formations.

We developed a comprehensive geological model using well-to-well log-correlations between 80-450 meters, below 200 meters seismic interpretation. In this model we separated five different stratigraphic units.

For modeling groundwater flow systems we have to decide if a stratigraphic unit is an aquifer, aquiclude or aquitard. However, during this conversion, the hydraulic properties can overrule the stratigraphic units (Aadland & Bledsoe, 1990). This problem was eliminated by the approach defining rather homogeneous facies/lithological units then sequence stratigraphic units. This simplification can enable to consider the boundaries of the stratigraphic units as surfaces where the hydraulic conductivity, porosity and/or permeability changes significantly. Thus the hydrogeological model contains surfaces representing the borders of the different aquifer and aquitard units.

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Elastic thermobarometry on quartz and zircon inclusions from a high-pressure granulite of the Cabo Ortegal Complex: a novel approach

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Poster

Elastic thermobarometry is a non-classical approach of thermobarometry as relying only on mechanical properties (like thermal expansivity and compressibility) of a mineral inclusion and its host, rather than chemical equilibrium. A crystal entrapped as an inclusion during mineral growth (i.e., quartz inclusion in garnet), is not free to expand or contract like a free crystal, but is constrained by its host mineral. Thus, as pressure-temperature (P-T) conditions change, e.g., during exhumation, the volumes of the host and inclusion change differently resulting in development of residual pressure. These differential volume changes cause either compressive or tensile

stresses. Quantification of these local stresses allows calculation of entrapment P-T conditions, giving rise to the field of elastic thermobarometry (Kohn et al., 2023).

Fluid and mineral inclusions in metamorphic rocks may play significant role to unravel fluid-involved processes in subduction-zones, therefore provides essential contributions to the nature of geochemical processes and element cycling in present day subduction zones. Metamorphic processes in subduction zones have first order effects on the changes in mineralogy, rheology and density of the Earth's lithosphere. In this work, we present results combining quartz-in-garnet and zircon-in-garnet Raman spectroscopy-based elastic geothermobarometry with Ti-in-quartz trace element thermometry from a granulite of the Cabo Ortegal Complex, Spain.

The studied quartz and zircon inclusions occur within garnet, together with rutile and multiphase fluid inclusions (MFI). Textural evidence showed that both crystal inclusions and MFI were likely entrapped simultaneously. These MFI, built up by step-daughter minerals (Fe-Ca-Mg-carbonates, pyrophyllite, quartz, corundum ± graphite) together with a residual fluid phase of CO_2+N_2±CH_4 are products of post-entrapment reactions of an originally homogeneous COHN fluid with the garnet host (Spránitz et al., 2022). This fluid was dominated by H_2O and CO_2 with no sign of trapped melt phase, afterwards involved in fluid-host reactions with the garnet (Spránitz et al., 2022). Hence, the application of elastic thermobarometry to quartz and zircon inclusions in these rocks provides the opportunity to estimate P-T environment of entrapment. Results from Raman spectroscopy on multiple quartz and zircon inclusions showed that the remnant elastic inclusion pressure (P_{inc}) at room conditions for both (on average 0.51 ± 0.04 GPa and 0.72 ± 0.05 GPa for the quartz and zircon inclusions, respectively) fall within the range of 2σ uncertainty confirming the crystallization within the same growth-stage of garnet. Intersection of the entrapment isomekes is at a P-T of 1.8 ± 0.2 GPa and 880 ± 70 °C. Isopleths calculated from Ti-in-quartz thermometer on quartz inclusions from the same garnet zone assign fairly the same entrapment P-T conditions, that is 1.8 ± 0.2 GPa and 860 ± 70 °C. Besides, we applied two different reference materials (natural and synthetic) for zircon-in-garnet elastic thermobarometry and compared them using the independent Ti-in-quartz trace element thermometry.

Our findings indicate that elastic thermobarometry on mineral inclusions provide a reliable constraint on trapping P-T conditions of coexisting fluid inclusions thus offers an excellent tool to obtain entrapment conditions of inclusions that cannot be re-homogenized and/or experienced partial H^2O loss during exhumation. The obtained P-T estimates provide a contribution to the nature and timing of subduction fluid processes, which is of great importance to better understand subduction zone metamorphism and global element cycling.

This research was supported by the NKFIH_FK research fund nr. 132418; the MTA FI Lendület FluidsByDepth grant to Márta Berkesi and the ÚNKP-22-4 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

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Subsurface Temperature Model of Hungary

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Poster

In 2023, the Geological Directorate of SARA launched the Complex Geothermal Research Program that aims to collect and organize all available geological, hydrogeological and geophysical data regarding geothermal decision-making. These data packages are organized by locations across the country, mainly based on major heat consuming areas. In the past decades of the geothermal growth in capacity and technology, geothermal heating and energy production are within reach for investors seeking green energy. Our Program at SARA concerns the public service geo-experts helping to identify geothermally desirable areas for non-governmental entities, as such facilitate the availability of independent, renewable and low emission energy sources for the public. As part of the packages, thermal data

collected from boreholes is a key ingredient. Our work within the project is to merge and improve the existing temperature databases.

Our merged temperature database was created based on the famous Dövényi Database (Geothermal Thermic Map (Hungary), [1]) and the Hévízkút kataszter (National Thermal Well Cadastre [4]). Additional partial databeses were used as well. A major revision was performed as some records were missing or incorrectly featured.All duplicates were eliminated.

The filtered temperature dataset was analysed as a whole and subdivided by geological formations: basement and Pannonian (Lower Pannonian, Upper Pannonian). The different geothermal gradients were calculated for these units and new temperature maps were created to these boundaries. Little over 18’000 temperature measurements were assembled and organized.

As part the SARA’s Complex Geothermal Research Program we revisited existing thermal and geothermal databases. We carried out a general data filtering and organizing. The databases were merged, and this complex thermal database is available for future use.

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Evaluating the detection efficiency of the BlitzOrtung network and studying the lightning climatology over Hungary

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Poster

Being one of the natural hazards and an indicator of severe weather, studying and evaluating lightning activity has a well recognized role in scientific research. The detection of lightning activity with a good efficiency is crucial not only from the point of view of protecting

human lives and minimizing economic losses, but to get a better understanding of Earth's climate system as well.

There are several solutions for detecting lightning both by ground-based networks (e.g., Earth Networks, EUCLID, LINET, WWLLN, etc.) and from satellites (e.g., GLM, LIS, OTD). The BlitzOrtung (BO) is a dynamically developing, community-based lightning detection network (Wanke et al., 2014). By 2018, the BO had circa 2000 stations around the globe (Narita et al., 2018) and their data are used widely in Europe. However, there is a need to evaluate the detection efficiency and compare the parameters of the detected lightning strokes with the ones derived from other state-of-the-art networks (Narita et al., 2018).

In this study, we aim at evaluating the performance of the BO network on a statistical basis. First, the detected lightning strokes are paired with those reported by the LINET and WWLLN systems using the time and location information. Then the geographical distribution as well as the temporal stability of the number of detected events and the percentage of paired events are examined. The first results of a pilot analysis over Hungary (45.5°–49° N, 16°–23° E) will be presented. This project serves to establish a comparison-based method for the evaluation of the lightning climatology of a region.

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Evolution and water content of the Firiza calc-alkaline basalts, Gutai Mts., North-Eastern Carpathians

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Applied

In this work we studied the Firiza calc-alkaline basalts, which are the youngest phase of volcanism in the Gutai Mts. Volcanic Zone

(Kovacs et al. 2013, 2017). The main goal was to uncover the magmatic water content during the genesis of the basalts. For this goal we used the structural hydroxyl content of clinopyroxenes (~100-500 wt.ppm H2O) from the basalts measured by Fourier Transform Infrared spectrometry (FTIR). Afterwards we calculated the equilibrium water contents using the chemical composition and structural hydroxyl content of the clinopyroxenes, based on the methods of O'Leary et al. (2010). For the correct interpretation of these water contents, we need to understand the evolution of these basalts focusing on the clinopyroxene phenocrysts. To better understand the evolution of the basalts we have done detailed petrographic observations and SEM-EDS studies on the selected samples. In my presentation I will show our results about the crystallization processes during the genesis of the basalts, focused on the role of the clinopyroxenes, and provide context to the acquired water contents.

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Predicting the "geothermal reinjection potential" into a deltaic reservoir formation in the Zala region (SW Hungary) based on the datasets of the hydrocarbon industry

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Poster

Although the preliminary geothermal potential of the Zala region is assessed to be good, the sustainable thermal water use requires a significant improvement in the proportion of the reinjected fluid. However, the so-called Pannonian porous reservoir formations are

often sources of various injection related issues ranging from regional through reservoir scale and local (e.g., clogging) problem sources. Predicting these issues helps to mitigate them which is required for a successful injection campaign.

This joint project with the MOL Plc. is supported by the motivation of oil businesses to move towards green energy and supported by the data already collected in the past during hydrocarbon exploration. The seismic and geophysical datasets offer enormous possibilities in the geothermal reutilisation.

In this current study we specifically consider the reservoir parameters by determining the location of the sand-prone volumes of the deltaic aquifer. This is done by interpreting 3D seismic volumes and by amplitude extraction. The amplitude maps are used combined with well-logs to delineate the best reservoir segments. The outcomes of the study help to predict the geothermal reinjection potential of specific subregions (i.e., where to drill the next reinjection well) as well as to assess the reinjection potential of the existing hydrocarbon wells.

The first author was supported, and the research was financed through the KDP-2021 Cooperative Doctoral Programme of the Ministry of Innovation and Technology (Hungary) from the source of the National Research, Development and Innovation Fund, grant number: KDP_2021_ELTE_C1789026. The study was funded by the National Multidisciplinary Laboratory for Climate Change, RRF-2.3.1-21- 2022-00014 project.

Modelling of a nuclear borehole geophysics tool used for CCS monitoring measurements in sandstone reservoirs

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Poster

One of the major struggles faced by humanity in the 21st century is global warming. A possible way to fight climate change is to store carbon dioxide in geological reservoirs. For the successful implementation of a CCS (Carbon Capture and Storage) project, it is essential to monitor the injected carbon dioxide. Borehole geophysics is an inevitable and effective part of such a monitoring system. However, the measurement conditions – particularly the well casing – limit the repertory of the available borehole methods that can be

utilized to determine the degree and the evolution of the carbon dioxide saturation. Therefore, neutron source-based instruments play a key role due to their large penetration depth. However, it is challenging to detect directly the presence of carbon dioxide by these tools, e.g. from the changing carbon content by C/O logging [1]. On the other hand, they show great sensitivity to changes in hydrogen content which decreases after CO2 displaces the pore water, so this provides a way to indirectly measure carbon dioxide saturation. In favor of obtaining results independently of the salinity of the water in the rock, it is preferable to measure gamma photons produced by the inelastic scattering of high-energy neutrons (a few MeV) instead of directly measuring (thermal: 0.025eV) neutrons. This is due to the high reaction cross section of chlorine for low energy neutrons. We used the MCNP (Monte Carlo N-Particle) software – which is implementing the Monte Carlo method for particle transport calculations – in order to model the time-dependent neutron-gamma transport problem of a pulsed neutron borehole geophysics sonde. We studied the effect of the carbon-dioxide saturation, the rock porosity and compositions and the casing diameters on the gamma photon spectrum calculated in the scintillation detectors of the tool. Additionally, we will show in our presentation how the sensitivity of the measurement to carbon dioxide saturation can be increased in sandstone reservoirs by just a carefully chosen energy window for the gamma detectors.

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Assessment of geothermal potential and compilation of data packages in Hungary

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Poster

The filtered temperature dataset was analysed as a whole and subdivided by geological formations: basement and Pannonian (Lower Pannonian, Upper Pannonian). The different geothermal gradients

were calculated for these units and new temperature maps were created to these boundaries. Little over 18’000 temperature measurements were assembled and organized.

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3RD SESSION

Pore network characterization and permeability estimation: application of XCT in pore network analysis and flow analysis in porous medium

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Applied

In recent years, there has been a growing interest in studying the flow of fluids in porous media through pore network characterization and permeability estimation. X-ray computed tomography (XCT) is a non-destructive imaging technique that provides a detailed 3D

representation of porous media, making it a useful tool in this area of research. In this study, machine learning techniques were employed to select a threshold window for gray-scale XCT images and segment XCT images of carbonate rock samples. The binarized images were then used to build a 3D representation of the pore network model, which was used to simulate and study the permeability and flow properties. The simulation results were used to predict the permeability values in the X, Y, and Z directions, and 3D and 2D visualizations of the pressure field, velocity streamlines, and flow magnitude were presented. The study found that flow was more consistent in the Z direction compared to the X and Y directions, and that there was lower permeability and flow rate in the Z direction than in the X and Y directions. In addition to the previously mentioned findings, this study also generated a scatter plot using Matlab to investigate the correlation between the area fraction and flow rate in each direction it was found that the majority of the flow originated from pores with a small area fraction, indicating that these pores played a significant role in the overall flow behavior. Specifically, more than half of the flow was observed to originate from these smaller pores. Overall, this study provides valuable insights into the flow behavior of porous media, with potential applications in fields such as petroleum engineering and geology. Moreover, it highlights the application of XCT in pore network analysis and flow analysis in porous media. The findings of this study demonstrate the potential of XCT in providing valuable insights into the flow characteristics of porous media and in estimating permeability with potential applications in fields such as petroleum engineering and geology. Further research is needed to optimize the use of XCT in the pore network analysis of porous media and to develop more accurate permeability models.

Numerical modelling of groundwater age in synthetic and real groundwater systems

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Theoretical

It is broadly accepted that groundwater flow is induced by a pressure or hydraulic head gradient and its main transport process is advection. Using this simple insight, particle tracking has become the most preferred technique for groundwater age calculation in numerical modelling (e.g., Szabo et al. (1996)). Yet, this method neglects the effect of other important transport processes, such as diffusion and dispersion, making the results less precise. The concept of "age mass" introduced by Goode (1996) uses a modified version of the mass transport equation providing a more appropriate approach for groundwater age calculation. The objective of the present study was to test Goode's method in synthetic and real groundwater flow systems.

In the framework of this study the groundwater age was modelled using COMSOL Multiphysics, a finite element numerical software package. During the theoretical simulations two different geometries were constructed: a 2D half-cosinusoidal unit basin, and a 3D basin after Wang et al. (2016), and the coupled time-dependent simulations were run until they reached the stationary solution. In the study an extensive series of parameter test were accomplished to investigate the effects of model parameters such as permeability, permeability anisotropy, amplitude of the water table, longitudinal dispersivity, inhomogeneity and depth of the unit basin on the groundwater age.

It was found that decreasing the permeability of the basin, both the mean and the maximum age increased as a hyperbolic function. With the increase of the longitudinal dispersivtiy, the age of the groundwater slightly decreased, but the dispersion mainly affected the distribution of the age as it dispersed the anomalies similarly to a smoothing filter. The parametric sweep of the permeability anisotropy revealed that the age increases monotonically when the anisotropy is enhanced. Increasing the model depth from 100 m to 5000 m made the mean and maximum age of the groundwater increase as well, as the flow system became deeper, regional flow was able to develop, raising the ages significantly. It was established that by raising the inhomogeneity (exponential decrease of permeability with depth) of the model, the age of the groundwater increases especially in the deeper parts of the basin. Raising the amplitude of the water table returned a hyperbolic decrease in the groundwater ages, because the higher amplitude values caused a more intense flow in the groundwater system, and thus old water could not accumulate in the

basin. In the 3D synthetic basin, the amplitude of the water table had both regional and local components, which altered flow patterns and the age distributions in a complex way.

Furthermore, a 3D simplified model of the Buda Thermal Karst system was completed to investigate the feasibility of a coupled age and heat transport model in a case study.

The research was carried out in a framework of project No. 142660 from the source the National Research, Development and Innovation Fund.

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Delineation of near-surface volcanics Applying turning-ray tomography and drilling date in the area of Bodrogköz

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Applied

In certain fields of earth sciences, it is important to determine the exact location and extent of subsurface volcanic rocks, even for future drilling, because the hardness of these rocks is very high and their presence may cause difficulties during drilling. In my research, I have been working on the delineation of shallow volcanic rocks applying turning-ray tomography and drilling data in the area of Bodrogköz, Northeastern Hungary. The seismic data on which my research was based, was collected by the Hungarian Mining and Geological Survey in the summer of 2021, when I had the opportunity to participate in the field measurements.

The geological information and the drilling data in the area show that volcanic rocks, including rhyolite tuff, andesite and basalt, are found at shallow depths below the surface. The raw shot gathers of the seismic data also show two sections where the so-called shingling

phenomenon appears. Based on information collected from the literature, shingling may indicate shallow, thin, high velocity layers beneath the surface. I have attempted to delineate shallow volcanics by a combination of examination of shot gathers, interpretation of drilling data and refraction seismic tomography.

To apply refraction seismic tomography, I picked the first arrivals in the shot records by tracing shallow refractors causing shingling, and deeper refractors. I defined an initial velocity field and carried out the inversion, resulting in 2D p-wave velocity profiles which characterize the acoustic velocity distribution of the investigated areas.

Applying complex interpretation of stratigraphy of the near-section boreholes together with the velocity profiles helped to explain and interpret the subsurface velocity relationships, so I was able to delineate the shallow volcanic bodies both in horizontal and vertical directions exposed by the boreholes.

The geotouristical properties of Nagybörzsöny

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Theoretical

The present study is part of a geotourism civil project that aims to present the geology-culture symbiosis of the village Nagybörzsöny located at the western part of the Börzsöny Mountains northern Hungary. The history of the village goes back at least 900 years during which it was also known as Bersen, Börzsöny and Deutschpilsen. The rock lithology in the village region is very diverse as magmatic, sedimentary and metamorphic rocks can be found from which the first two were extensively used by the village inhabitants. Magmatic rocks (e.g., andesite) are linked to the adjacent Börzsöny Miocene volcanism and were used mainly for construction for example houses and fences. Sedimentary rocks are limestones, sandstones (both belonging to the Lajta Formation), claystone

(Szilágyi Formation) and pebbles (formed after the collapse of the Börzsöny volcano). Claystone was primarily used for building stoves, whereas pebbles were used for construction of houses and walls. Metamorphic rocks occur only as crustal xenoliths hosted by the Miocene subvolcanic rocks and originate from the Vepor Unit found approximately 1 km below the surface. The weathering (i.e. the formation of soil) of the volcanic and sedimentary rocks lead to high quality agriculture. As a result, in the 16th century Nagybörzsöny was one of the best known wine region in Hungary owning the rank of 'agriculture town'. Furthermore, Nagybörzsöny is also known for the abundant metal occurrence (e.g., gold, silver, copper; formed during porphyry copper ore mineralisation) associated with various critical elements like Bizmuth and Tellur. From these ore deposits two new minerals were described: Pilsenite (Bi_4Te_3) and Jonassonite ($AuBi_5S_4$). The oldest records of the mining industry dates back to the 13th century and lasted until 1962 and was dominantly executed by Swabian miners. One of the most prominent evidence regarding the long mining culture is the presence of the Miners' church (Bányásztemplom in Hungarian) built in the 13th century. Some of the most known ore mines are Ércbánya/Altáró, Rózsa-bánya and Bányapuszta that are associated with large waste-dumps. These waste-dumps (and local ore processing centra) have a huge impact on the local environment as the weathering of the deposited sulphide minerals leads to significant acidification of the adjacent environment. Based on the rich geological environment and geological culture, Nagybörzsöny would serve as a great geotouristical attraction.

Using 2D balancing to quantify the scale of the Miocene extension of the Danube Basin

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Theoretical

The Danube Basin is a prominent sub-basin of the Pannonian Basin, forming a transitional zone of the Eastern Alps and the Western Carpathians on the border of Slovakia, Hungary, and Austria. During the Miocene, the lithosphere of the Pannonian Basin underwent considerable rifting, leading to the formation of the Danube Basin [1]. During this process, previous studies [2][3][4] have investigated the timing of the opening of several grabens and half-grabens in both the Slovakian, Austrian, and Hungarian parts of the basin.

The main objective of this research was to quantify the extension occurred in the Danube Basin during the Miocene. Using seismic sections crossing the particular grabens which were interpreted in previous research [4], we carried out 2D balancing of the sections, which is an area-preserving structural modeling method used for the reconstruction of the status of the geological layers before its deformations.

With the outcome of this research, we were able to define the scale of the horizontal lengthening along the sections in meters and percentages, thereby giving an estimation of the scale of the stretching of the upper crust suffered in the study area during the Miocene rifting. Based on the preliminary results, the scale of the extension can be estimated at approximately 20–40%. This value is in line with the results of [5], and can be compared with the results of [6] and [7]. In the future, our result can be refined by integrating balanced outcrop sections and by 3D balancing for the entire area.

The research was supported by the National Research, Fund of Hungary (NKFIH) OTKA within framework of projects No. PD 142660 and No. 134873.

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Paleoenvironmental reconstruction of the dinosaur localities in the westernmost part of the Haţeg Basin

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Applied

A rich dinosaur-bearing fossiliferous sites of the Haţeg Basin (Southern Carpathians, western Romania) excavated by Ottokár Kadić at the beginning of the 20th century was rediscovered in 2019. Aside from the re-excavation of the previously known fossiliferous outcrops, additional bone-bearing horizons were discovered. A systematic collection of vertebrate fossils was supplemented by sedimentological analysis of the hosting sediments.

The aim of this study is the sedimentological description of the fossil bearing uppermost Cretaceous (Maastrichtian) deposits, belonging to the Densuş-Ciula Formation, outcropping in the westernmost part of the Haţeg Basin. Furthermore, the reconstruction of the palaeoenvironmental conditions, in which the specimens were accumulated and preserved.

The examined sediments can be grouped into four facies association each representing a specific sub-environment of the depositional system. Majority of the sedimentary succession is dominated by thick intervals of fine-grained, poorly sorted, reddish, brown mudstone deposits frequently containing sand and gravel clasts with signs of bioturbations and calcareous concretions, ranging from isolated calcretes to continuous layers. These thick intervals correspond to waterlogged, poorly-drained floodplain sediments deposited in the proximity of the main river channel complex. Intervals where paleosols were observed represents better drained floodplain conditions located further away from the main channel axis. The

floodplain sediments are interbedded with poorly-sorted, matrix or clast-supported gravel beds. They can attain thickness up to 2-3 metres and mostly like deposited during subaerial debris flow events on the prograding medial or proximal parts of alluvial fan bodies and/or un-channelized flow events on the floodplain.

The thick monotonous intervals of muddy floodplain sediments are frequently interrupted by by 10 cm to 1.5 m thick, channel shaped erosional bodies filled up by sand or gravelly-sand occasionally showing through cross-stratification and cross-lamination. The channel body fills frequently show a fining upward trend with gravel clasts paving the erosional surface followed by sand, occasionally overlain by grey mudstone. This observed vertical trend indicates decreasing flow energy trough the deposition with the occasional deposition of fine-grained slackwater deposits. The erosionally bounded channel bodies correspond to braided fluvial channels, that cut into the muddy floodplain sediments. Given that these fluvial channels frequently stacked erosionally upon one another and are not distributed evenly within the succession it can be assumed that they formed channel complexes which were constantly shifting location on the alluvial plane.

The fourth facies association is built up by black and grey mudstone deposits interbedded with silty sandstone beds, containing abundant plant fragments and molluscs. These three facies are organised into three 2.5, 2 and 2.5 m thick cycles vertically stacked upon each other forming a 7 m thick sequence. The last cycle is capped by fluvial channel deposits, and the facies association is underlain by floodplain sediments. These deposits most likely represent a floodplain lake environment.

Vertebrate fossils were found in the sand beds of floodplain lake sediments and in fluvial channel deposits. In case of the latter dinosaur bones were transported and deposited together with the coarse material of the channel lag but were also found within the channel fill and in the muddy deposits capping fluvial cycles.

In conclusion the examined sedimentary succession represents continental deposition in a braided fluvial environment, most likely as part of an alluvial fan system, which was built up by huge amount of clastic sediment eroded from the uplifting basement due to a compressional tectonic regime.

This study was supported by the NKFIH OTKA PD 131557 research fund.

4TH SESSION

Some aspects of the interpretation of magnetic maps

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Theoretical

The correct interpretation of magnetic maps constructed from data measured for discovering local magnetic anomalies may encounter several problems. The aim of my presentation is to draw attention to the effects of some fundamental factors we must calculate upon. Neglecting them may cause significant distortion in the information content of the results produced by means of the mathematical operations applied during the phases of data processing and interpretation. The investigations were focussed on the role of sampling distance and measurement grid (equidistant, non-equidistant and incomplete grids), as well as on the effects related to the parameters of geomagnetic field and remanent magnetism. As the Two-Dimensional Discrete Fourier Transform (2D DFT) and its inverse are widely used for filtering in the frequency domain, their behaviour under different conditions was also studied to point out some disadvantageous phenomena.

Muography direct problem modelling for geophysical applications

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Theoretical

Muography uses cosmic ray muons to image the inner structrue of large objects, like geological formations or artificial buildings. This multidisciplinary novel technology invoked detailed research and development worlwide, investigating its applicability, upgrading detector designs, and using for geophysical research.

The Innovative Gasoues Detector R&D Group in the Wigner RCP in Hungary is a wellknown team of the muography community, focuses on technological advancement and applications.

I have developed a mathematical model to describe the measurable muon counts, taking into account muograph geometry, inclination, and various detector and tracking-algorithm effects. This way, via predicting the detectable muon counts from the local flux, advanced measurement planning become possible: determining time and uncetainty levels for the expected anomalies.

The model has been compared with raw muography data for both laboratory and underground campaigns; and has proven validity on large and small systems as well.

It open a way to investigate the optimization of double-inclined-survey idea; and detector-compisition for borehole muographs.

Preliminary petrography and fluid inclusion data from the Ostra polymetallic mineralization (Eastern Carpathians, Romania)

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Theoretical

The Ostra polymetallic mineralization (Suceava County, Romania,) is situated in the northern range of the Eastern Carpathians. The Tulgheș Series of the highly diverse Bukovina Nappe System is one of the most important host of raw materials in the Eastern Carpathians, hosting various polymetallic Pb-Zn-Cu-Au-Ag, Cu-pyrite, barite, Fe-Mn, and uranium mineralization associated to Cambrian-lower Ordovician volcano-sedimentary sequences and intrusions which experienced greenschist to amphibolite facies metamorphism during Variscan and Alpine orogeny.

At Ostra, the prospecting and exploitation of barite and metals started in 1955, and the mining lasted until the 2000s. However, only a few old studies addressed this mineralization, therefore detailed mineralogical, mineral chemical and geochemical data is not available, its genesis is debated, as well as no detailed modern genetic model is set up. Our present study aims to contribute to these aspects,

which could help to better evaluate the economic significance of this prospect.

We completed field observations, whole rock geochemical (XRF) analysis, detailed petrography complemented with SEM-EDS observations, electron probe microanalysis (EPMA) and fluid inclusion studies to achieve the abovementioned goals. Detailed field mapping was performed in order to understand the outcrop-scaled structural features and geometries of the mineralization. We have identified several massive sulphide lenses, which were always associated to the porphyroid rocks. Argillic alteration of the immediate host rock is common. Barite occurs in two textural and paragenetic relationships: it can be either associated with distal parts of the massive sulphide lenses, or it can form massive bodies (without sulphides) in the porphyroid rock.

The massive sulphide lenses consist mostly of pyrite, chalcopyrite, sphalerite, galenite, covellite and fahlore, but leading to its distal parts, gangue minerals (coarse grained, euhedral barite, rare fine-grained quartz) may also occur in them. Fluid inclusions of barite in the distal parts of the massive sulphide lens were studied. Based on our preliminary results, the primary fluid inclusions (occurring in growth zones or in the spongy cores of the baryte crystals), revealed a homogeneous parent fluid, which can be modelled in a $NaCl\text{-}H_2O$ system. Despite the small size of the primary liquid + vapour fluid inclusions (usually 4-7 μm), their chemical composition and physical properties can be determined: 145-185°C minimum formation temperature and 3.7-5.3 NaCl equiv. wt% salinity was confirmed. This slightly higher salinity compared to modern seawater values can be the result of fluid-rock interaction during the hydrothermal fluid circulation in the oceanic crust.

Trace element compositions were measured in barite, pyrite, sphalerite, chalcopyrite, galena and fahlore. Sphalerite from the proximal part of the massive sulphide lens contained significantly higher amount of Fe (up to 8.1 wt%), compared to the distal ore (0.6-1.2 wt%). This suggest lower formation temperature for the distal ores, which corresponds to the low (<200° C) minimum formation temperature of the syngenetic barite. Galenite and fahlore showed compositional differences according to their location in the massive sulphide lens: distal galenite contained elevated Zn, while distal

fahlore was characterised by elevated Hg and low Sb. The Ag content of the deposit is connected to the fahlore, no other Ag-bearing mineral was observed.

Naturally occurring radionuclides in a riverbank filtration system – potential health threat or indicators of temporal variability

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Poster

Due to global changes, the demand for drinking water of the right quality and quantity is increasing. Groundwater resources are depleting; thus, there is an urgent need for sustainable drinking water sources. The riverbank filtration (RBF) systems are cost-effective, sustainable sources. The RBF technology has been widely used in Hungary, mainly along the Danube. However, RBF systems are strongly dependent on the river stage. Therefore, climate change-induced extremely low or high river stages may cause water quantity and quality problems.

The focus of the present study is an RBF system in the vicinity of Tass settlement (Bács-Kiskun county, Hungary) that we investigated from a radioactivity point of view. During drinking water quality monitoring, gross alpha activity was measured above the 100 mBq L^{-1} limit value in some wells. Therefore, we aimed to understand the cause of the elevated gross alpha activity, assess the potential health risk and examine the relationship between the water quality variation and river level fluctuation.

Altogether ten producing wells, two monitoring wells, and the Danube were sampled at lower (90.66 m asl) and higher (90.92 m asl) river stages. The water samples were analysed for major ions and trace components. Total U ($^{234}U+^{235}U+^{238}U$) and ^{226}Ra activity concentration were determined by alpha spectrometry using Nucfilm discs, and ^{222}Rn activity was measured by liquid scintillation counting.

Total uranium activity was measured in the highest concentration (up to 334 mBq L^{-1}) among the examined radionuclides. However, ^{226}Ra and ^{222}Rn activities were barely above the detection limit. Based on our results, the elevated gross alpha activity is most likely caused by dissolved uranium in the groundwater. Uranium activity concentrations show an increasing trend from north to south along the Danube, which corresponds well to the occurrence of organic matter-rich, clayey floodplain deposits underlying the sandy-gravelly aquifer.

Besides spatial variation, a temporal change can also be observed: lower uranium activity was measured at a lower river stage (32–248 mBq L^{-1}) compared to activities at a higher river stage (26–334 mBq L^{-1}). The dynamic relationship between the groundwater and the river could explain this phenomenon. At the low river stage, oxygen-rich (ground)water flows toward the inland and may cause uranium remobilisation from the clayey basement layers. This process will be more and more dominant by extremely low river stages during long-lasting drought periods in the future, causing water quality problems.

The research was funded by the National Multidisciplinary Laboratory for Climate Change, RRF-2.3.1-21-2022-00014 project.

A detailed study of the 2D travel-time tomography problem and its application to calculate phase velocity maps

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Poster

Nowadays, seismic tomography is one of the most commonly and effectively used methods for structural research. The results of the last decade have led to the development of reliable methods that exploit the ubiquitous ambient noise. My research aims to investigate in detail the 2D travel-time tomography method based on seismic noise and then apply the method to the Carpathian-Pannonian transition zone to produce phase velocity maps.

Dispersion curves as input data for tomography were already available due to my previous work, and a software package for inversion calculations was developed as part of this research. The method was subjected to synthetic tests to verify its operation. I then

carried out a series of parameter tests to estimate the optimal value of the key coefficients. After extensive testing of the method, I performed 2D tomographic inversion with the available data system. The results allowed the determination of the horizontal variations of the velocity field at several different depths.

It can be said that the established method works reliably for 2D problems and the resulting phase velocity maps can contribute to a better understanding of the tectonics of the region.

Tectonic reconstruction and HC trap types of the North Hungarian Paleogene Basin (NHPB)

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Theoretical

The North Hungarian Paleogene Basin (NHPB) is one of the focus areas for hydrocarbon exploration in Hungary, and a potential target for several subsurface developments such as geothermal or Carbon capture, utilisation and storage (CCUS) projects.

The aim of this study was to understand and define trap types of HC fields at the area of interest in structural point of view. In this presentation I would like to summarize the seismic interpretations of 3D seismic data from the NHPB, and conclude the results in 3D paleo-reconstruction models.

The sediments of NHPB were deposited from Eocene to Middle Miocene in deep marine to terrestrial environments in several depositional cycles (Tari 1994, Vakarcs 1997). Beside eustasy the tectonic had a significant role in basin geometry and facies distribution due to local changes of accommodation space. This study is focusing on the role of faults in that processes.

The earlier published transpressional model of Palotai (2013) was validated here as well. The paleo-geomorphology was mainly defined by syn-depositional tectonic structures. The analyzed seismic data suggest transpressional settings for Eocene and Oligo-Early Miocene, which could be correlated with the observations of outcrops in the Buda Hill also. In the tectonic regime a significant inversion occured where the previous ENE-WSW right-lateral transpression changed to

left-lateral. This study presents observations which indicate Badenian timing for that at the study area.

In the discussion of this study the structural development is visualized for the southern part of the NHPB from Eocene to recent time. Based on tectonic observations, fault geometries and thicknesses of the tectono-stratigraphic units a paleo-reconstruction model was created to summarize and conclude the results. As a conclusion trap types of the known HC fields is defined.

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SATURDAY

5TH SESSION

Studying the structural hydroxyl content of nominally anhydrous minerals in South Harghita shoshonites

Dániel Kovács[1], Ágnes Gál[2], Alexandru Szakács[3], Thomas Pieter Lange[1,4,5,6], Ákos Kővágó[1,7], Csaba Szabó[1,4], István János Kovács[4,6]

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Theoretical

The Luget and Murgul Mic shoshonitic volcanic domes, exposed in the South Harghita Mts., are the southernmost volcanic formations of the Călimani-Gurghiu-Harghita Neogene volcanic chain located in the eastern part of the Carpathian-Pannonian region. We studied the shoshonitic rocks from the northern and southern quarries in the Luget

dome area. The collected samples derive from different areas within each quarry to determine the lithological and geochemical features of the inner and outer parts of the volcanic dome. The main aim of our research was to determine the structural hydroxyl content of the nominally anhydrous minerals (NAMs) occurring as phenocrysts in the porphyric rocks from which we tried to determine the magma water content, in addition to the petrographic observations and petrogenetic interpretations. Based on the macroscopic textures we selected 10 samples that can be described as follows: typical shoshonites, banded shoshonites and "patchy" shoshonites. All samples contain biotite, amphibole, orthopyroxene, clinopyroxene, plagioclase, olivine, and quartz with apatite and titanite as accessory minerals. Of these minerals we focused on the clinopyroxene, olivine and quartz and determined their structural water content that is close to the detection limit in clinopyroxene and olivine, and 16 ± 6 ppm in quartz. Our results show that the studied mineral assemblages do not provide information about the original water content of the magma due to late-stage magmatic processes (e.g., oxidation). This assumes that in the case of volcanic domes measuring the water content of nominally anhydrous minerals is not a proper tool to determine parental magma water contents and it more likely provides information about the syn- and post-eruptive secondary processes affecting the volcanic body.

A thorough examination of the structural parameters for potential mineralization south of the Egyptian Golden Triangle

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Applied

The Mubarak-Barramiya shear belt is exposed orthogonally to the main fabric that extends in the NW-SE direction in the Central Eastern Desert as a part of the Nubian Shield (the western part of the Arabian-Nubian Shield). This belt is extensively intruded by multiphase magmatism ranging from syn-tectonic magmatism to late- or post-tectonic magmatism. Such regimes, especially along the sheared margins of these granitic intrusions or in contacts with different lithologies; Mubarak ultramafic rocks, are particularly widely

associated with many of the orogenic gold occurrences. Among these occurrences, the auriferous quartz veins and associated potential hydrothermal mineral alterations (i.e., propylitic alterations) and their relation to the master shear array are the target of this study. These veins form along extensional fractures as a result of post-amalgamation transtensional (i.e., the master shear array and related Riedel shears and tensional fractures) shearing, as a transition from transpressional (i.e., the master shear array and related P-shears, S-C fabric, and asymmetric folds) terrane accretion in response to Um Nar's shearing activity. These features perfectly coincide with two major shortening events that occur roughly in the ENE-WSW and NW-SE directions as a result of the initiation of the Um Nar sinistral master shear, which refer to reactivation at the shallow crustal level in the late-stage with a dextral shear sense of motion, indicating repeated mylonitization, recrystallization, hydrothermal fluid circulation, and finally precipitation in extensional fractures. The study of the type, orientation, and geometry of these extensional fractures and host rocks, which developed through these shear array-related extensional fractures, provides insights on the shear activity and, consequently, the tectonic history of the area. As a consequence of this, we applied an integrated approach to resolving the complicated structural pattern within the study area. This approach includes integrating detailed fieldwork (structural measurements and petrographic-oriented samples), remote sensing, and aeromagnetic data in order to shed light on their roles in localizing ore deposits and potential hydrothermal alterations within the extensional fractures forming auriferous quartz veins. Several remote sensing image processing techniques, including false color composites (FCCs), band ratios (BRs), principal component analysis (PCA), minimum noise fraction (MNF), and decorrelation stretch (DS) are applied to ASTER, Sentinel 2, and ALOS PRISM data to meticulously understand this complicated structural regime. ALOS PRISM results constituted the best choice for spectacular discrimination and classification of the exposed granitoids and recognition of the transtensional system intruding on the Mubarak-Barramiya post-accretionary belt. These fracture systems are primarily responsible for the transmission of potential hydrothermal alterations. The structural network of this fracture system greatly enhances the permeability within these Neoproterozoic rocks,

allowing the precipitation of various potential mineral deposits as quartz veins due to the passing of hydrothermal fluids. Economically, these results may be significant for future prospecting in newly potential zones in this sector.

Variscan S-type granitoids in the Codru Nappe System (Apuseni Mts.): petrography, whole-rock geochemistry and correlations in the Tisza Mega-unit

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Theoretical

Variscan granitoids occur in various locations of the Palaeozoic basement of the Tisza Mega-unit, both exposed on the surface

(e.g., Apuseni, Mecsek and Papuk Mts.) and buried deep beneath Neogene sedimentary layers (e.g., Algyő–Ferencszállás–Makó area, Battonya–Pusztaföldvár Basement Ridge). So far, these rocks have received little attention: petrographic and geochemical characterisations, as well as radiometric ages are only available to a limited extent, often containing incomplete or contradictory data. Some of the least investigated granitoids are found in the Apuseni Mts., one of which is the focus of our study: an exhumed pluton in the Codru Nappe System and its possible connection to the analogous Battonya granitoids (basement of the eastern Pannonian Basin). We aim to describe the petrography and whole-rock geochemistry of the Codru granitoids and explore potential relationships between these comparable formations.

At the sampling location, the Galşa quarry (SW Apuseni Mts.), the Codru granitoids appear as equigranular, medium- to coarse-grained, subhedral granular syenogranites (granites s.s.) cut through by aplite and pegmatite veins. The main rock-forming minerals of the granites are: quartz > K-feldspar > plagioclase > muscovite > biotite. In the aplites and pegmatites, the proportions of quartz, muscovite and microcline are higher than in the granites, plagioclase feldspar is less abundant, while biotite has not crystallised. Accessory minerals are

apatite, zircon and monazite, all of which generally occur as inclusions of micas. Mn-rich garnet crystals are common in the aplites, while the pegmatites often contain apatite with higher Mn concentrations. The samples are somewhat altered (sericitised feldspars, epidotised biotite) and show signs of brittle and plastic deformation. Most micas are aligned to two nearly perpendicular orientations, possibly caused by magma flow and acting shear stress during the emplacement and cooling of the pluton; however, the influence of subsequent deformations cannot be excluded either.

Despite the post-magmatic alterations, the granitoids have preserved their primary chemical compositions. All samples have subalkaline and mild–moderate peraluminous compositions. They are predominantly calc-alkaline and show magnesian character; only the aplites are alkali-calcic and ferroan. The veins are substantially less enriched than the granites in light REEs and moderately in heavy REEs. Trace element-based discriminations (e.g., Yb vs. Ta, Yb+Ta vs. Rb) suggest that only the aplites and pegmatites are syn-collisional, whereas the granites have an arc origin, despite their petrography and geochemistry indicating S-type characteristics. Considering other means of tectonic discriminations (e.g., Sr/Y and La/Yb ratios) and the findings of Broska et al. (2022) in the case of Western Carpathian granitoids [1], it is conceivable that the granites bear the geochemical signature of a slab failure, being both crust- and mantle-derived, while the shallower level melts of aplites and pegmatites represent purely crustal sources in the Variscan orogeny. This corresponds with the calculated zircon saturation temperatures (granites: 740–780 °C, aplites/pegmatites: 580–600 °C).

Compared to the results of earlier studies about the Battonya granitoids [2, 3], significant similarities were found: although the two granitoids barely differ in modal composition and texture, the basement rocks are predominantly inequigranular and less frequently oriented; however, the most remarkable resemblance between them is in their geochemistry, especially their major and trace element distributions, suggesting they might represent the same magmatism.

Preliminary datings of the Battonya granitoids [4] indicate that the main zircon crystallisation period occurred in the Early Carboniferous (~356 Ma), which fits nicely into the regional geological framework of the European Variscides.

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Late-Miocene vertebrate coprolites from Pécs-Danitzpuszta

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Applied

Thousands of coprolites (fossilized faeces) have been collected at the sand pit of Pécs-Danitzpuszta [Upper-Miocene (Pannonian), Kálla Member of the Békés Formation], which is one of the most important mixed Neogene vertebrate localities in Hungary. The locality has been known for centuries; however, the coprolites have not been investigated. Their age, exact origin, and way of preservation wasn't known, and it was unclear whether their producers had terrestrial, aquatic or semiaquatic lifestyles. The aim of this study was to document these fossils and explore their paleoecological significance. Morphological groups were established, measurements, surface marks and colour data were recorded. Twenty-three coprolites were examined with computed tomography. Thin sections were made. The mineralogical composition was studied with X-ray diffraction.

The size of the coprolites ranges from 1 to 9 centimetres, their colour varies between almost white and dark brown. Their surface is mostly smooth, occasionally with small pits and dents, while desiccation cracks were not observed. Nine morphotypes could be distinguished. All coprolites have the mineral apatite as their main component. The coprolites contain remains belonging to several groups: ostracods, bivalve shells, vertebrae from bony fishes, fish scales, as well as fish teeth. The CT scans show inhomogeneities in

the matrix; however, in most cases they are not reliable for finding and identifying inclusions.

The taphonomical features indicate rapid burial and most likely an aquatic origin. The spiral morphotype could be attributed to fishes with spiral intestinal valves. The phosphate content is most probably derived from a carnivorous diet, no evidence of herbivory has been found so far. Teeth of reef-associated fish taxa indicate Badenian age for some of the coprolites, though the coprolite assemblage might include younger specimens as well.

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Genetic study of the sphalerite from Rudabánya (NE Hungary)

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Theoretical

The Rudabánya Ore Complex, which is hosted by Lower Triassic carbonate and siliciclastic rocks, is known for its siderite deposits. Previous exploration reported the occurrence of various sulphides (e.g., galena, pyrite, chalcopyrite), stating they were only accessory minerals. Novel studies, however, confirmed the polymetallic character of the ore complex. According to our present knowledge, the mineralization formed during several overlapping events: (1) early stage, stratiform Pb-Zn ores; (2) metasomatic siderite hosted by dolomite in higher stratigraphic level; (3) Cu-Pb-Ba-Ag mineralization bound to the contact of the dolomite and the black shale; (4) supergene alteration of the primary sulphides and (5) juvenile low-temperature hydrothermal Hg-As-Sb-Ag enrichment. Recent researches suggest that there are two types of different Pb-Zn bearing sulphide parageneses (the (1) being presumably SEDEX and the (3) being presumably MVT), containing the same sulphide minerals. The minerals of the (1) type are forming massive layers or lenses, hosted mainly by the Lower Triassic calcareous siltstone successions, whilst the ore formation of the (3) type are bound the fault and breccia zones, and can be vein-filling also. Our current research focused on these two types of mineralizations as there are a lot of concerns about their genesis, which are not known in detail.

After field observations and drillcore sampling, we tried to reconstruct the formation conditions of the Pb-Zn ores, to reach this goal, transmission and reflected light polarising microscopy, SEM-EDS and EPMA studies were performed. Through macroscopic and polarizing microscopic observations, the two ore type can be clearly distinguished by their texture. Both the galena and the sphalerite are banded and fine-grained, pyrite can be framboidal as well as euhedral in the stratiform (1) ores. Textural evidence suggests that the pyrite precipitated through the whole mineralization process, while galena is an early-stage, sphalerite is a middle-stage and barite is the latest-stage mineral. Alterations of galena to cerussite/anglesite and sporadically sphalerite to smithsonite can also be observed. The gangue minerals are quartz, barite and various phyllosilicates (the latter most likely of host rock origin). As a contrary, the galena and sphalerite from the type (3) ore are massive and their grain size could vary. The early-stage pyrite grains are coarse while the barite is late void-filling. The gangue minerals are zoned carbonates (dolomite, magnesite, ankerite), calcite and quartz. Although the mineral association of the two different ore types is quite similar, their composition is different: the sphalerite of the (1) type ore contains unequivocally lower amount of iron (up to 0.2 mol% FeS), compared to the sphalerite of type (3) ore (commonly 3-8 mol% FeS). This suggests lower formation temperature for the type (1) ore (below 100°C) and higher formation temperature for the type (3) ore (100-250°C). More detailed EPMA analyses of the sphalerite revealed differences in their trace element content: sphalerite of the type (1) ore contains higher amount of Hg, Ag and lower amount of Cd compared to the sphalerite of the type (3) ore. The mineral chemical studies confirm the formerly presumed MVT s.l. (so-called Alpine-type Pb-Zn) deposit classification for the type (3) ore.

Re-examination of the wehrlite from Denevér-táró at Szarvaskő, Hungary: petrographic characteristics and sulphide melt inclusions.

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Theoretical

The ore indication (Fe, Ti, V, Ni, Cu) at Szarvaskő, Hungary carries economically important critical raw materials (CRM) derived from a low-grade metamorphosed wehrlite from the jurassic period. The research methods include SEM-EDS, ICP-MS and microscopic petrography. A complex evolutionary history was established, while special attention was paid to the interpretation and description of the Szarvaskő formation as well as a summary of its surrounding ore indications. Petrographic and ore genetic analysis revealed a new, previously unobserved chemical variability in magnetite associated with collateral primary and secondary processes: vanadium-rich and vanadium-poor magnetite occur in different microscopic fabric locations with different genetics. The occurrence of V-enriched magnetite, bearing important economic value, can thus not be indefinitely linked to primary magmatic processes - an observation that may provide a new perspective for the assessment of the ore indication. A further new finding is the occurrence of the mineral cubanite, which has not been previously described from the the ultrabasic rocks of Szarvaskő, but is an important genetic indicator: it provides information on magma evolution and plate tectonics. The sulphide melt inclusions imply that the magma reached sulphide-saturation at its late stage of evolution and was originally low in S, thus could not have produced a large-scale gravity segregation ideal for Ni/Cu ore deposit to form. Based on the relatively high amphibole content of the rocks and the potential contamination of the melt, the observations fit into a back-arc basin environment, in which assimilation of sedimentary host rocks is also a commonly known process. Comparing the trace element data with the different geochemical characteristics of foreign wehrlites as well as other magmatic rocks from Szarvaskő, several statements can be made. The 'missing' calcophilic elements from the wehrlite were dispersed in the surrounding extrusive/intrusive rocks, such as basalts, which is not ideal for a potential formation of a Ni/Cu ore deposit. In addition, the rare earth elements have migrated into the plagioclase-bearing gabbroic and basaltic rocks during magmatic differentiation, but accumulated plentifully in the plagiogranite of Szarvaskő.

6TH SESSION

Application of Strontium and its isotopes of $^{87}Sr/^{86}Sr$ for tracing urban soil contamination, a case study of Salgótarján, Hungary

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Theoretical

Soil is also an important part of the urban environment, which is changing quickly due to urbanization in terms of chemical composition, isotopic and physical features. Studies of the natural and anthropogenically influenced concentrations of elements and certain stable isotopes in the environment using background soil chemical compositions and stable isotopic ratios are required. Environmental indicators (e.g., stable isotopes) are practical resources for tracking conditions of urban environment in relation to sustainable development and related environmental threat. The application of stable isotopes, first in the fields of chemistry and geochemistry and later in biogeochemistry and ecology, is an extremely valuable and powerful tool for indicating (sourcing), tracing, and recording various changes to our lithospheric, hydrospheric and atmospheric system. Strontium isotopes used in soil sciences for decades, demonstrating their potential as significant tracers to describe chemical weathering and other pedogenic processes on both a short- and long-term scale. In addition, $^{87}Sr/^{86}Sr$ fingerprinting of heavy metal(loid)s widely used to trace the source and migration, as well as distribution of pollutants in urban environment. The major goals of this study are: 1) to study both levels of Sr concentration of the north-eastern part of residential area in Salgótarján and its spatial distribution with distance from local coal-fired power plant (CFPP) and 2) to identify major source(s) of

different Sr isotopes. Salgótarján city, one of the former industrial cities in Hungary, where 15 selected urban soil samples were studied in this paper. Samples were grouped within four categories of sampling sites: kindergarten (4 samples), park (3 samples), playground (4 samples), roadside (4 samples), and one sample from the local coal ash cone, as well as one brown forest soil sample were collected. Strontium concentration in urban soil samples show negative correlation with increasing distance from CFPP, however two small clusters of samples show opposite behavior. The ratio of $^{87}Sr/^{86}Sr$ isotopes in more than 50% of urban soil samples shows also positive correlation with increasing distance from coal-fired power plant. A binary mixing model was used to estimate relative contributions of natural vs. anthropogenic sources. Based on isotope source apportionment, the samples with the lowest and highest isotopic ratios ($^{87}Sr/^{86}Sr$: 0.7103 and 0.7196, respectively) are not the closest and furthest away from the CFPP indicating that the sample sites affected by additional, unidentified sources, which also influenced $^{87}Sr/^{86}Sr$ ratios in relation to distance from CFPP.

A newly discovered combustion metamorphic complex in the Miocene coal-bearing sedimentary units of Salgótarján Basin, Novohrad-Nógrád UNESCO Global Geopark

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Theoretical

Combustion metamorphism as a geological process produces unique metamorphosed rocks resembling siliciclastic contact metamorphic formations as well as modern ceramics. Industrial slag and ceramics looking rocks attracted our interest in our research area, in the eastern end of the Salgótarján Basin, N Hungary. The local combustion metamorphic complex that consists of clinker, pseudoconform buchite and paralava has been discovered by the geopark's geologist. The lithology of the outcropping units on the hillside varies on centimeter scale. The highest degree of alteration was observed on the samples from the chimney-structure, which were annealed by the gases

released from the coal burning process, and are characterised by melted or partially melted rocks, while the lowest degree of alteration was in the "clinker" metaaleurolite rock units.

Following field observations XRD, SEM-EDS and DTA measurements were carried out on the different rock types to describe the mineralogical and textural characteristics. Quartz is characteristic of all metamorphic rocks, mostly as relict grains, and all samples contain plagioclase with increasing Ca content with increasing metamorphic grade, often in several generations. In addition to these, clinker may contain biotite; buchite may contain K-Na-Ca feldspar, pyroxene and glassy matrix; and paralava rocks contain cordierite, pyroxene and feldspar. SEM measurements have shown that clinker samples have a relict sedimentary texture, whereas partially melted and melted rocks are characterised by an intersertal texture, in which plagioclase is often symplectitic and pyroxene nodules appear as pseudomorphs or have coccoidal shape along sharply defined formations, presumably replacing original sedimentary mineral grains. Based on our observations, the outcrop near Rónabánya is the first documented combustion metamorphic complex in Hungary.

Geochemistry of HFSE enriched rock bodies from Bükk Mts., NE Hungary – a geostatistical case study

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Applied

A high field strength element (HFSE) enrichment is known from the Bükk Mts., NE Hungary. The enriched elements are the rare earth elements (REE), Zr, Nb, Ta and Th. The enrichment is connected to Triassic metavolcanics and metasediments, embedded into non-enriched limestones. The elements are carried by various minerals, like zircon, Nb-bearing Ti-oxides, REE-phosphates, REE-carbonates and REE-Nb-oxides, all of them has only micrometric grain size. The results suggest that the enrichment has a metasomatic origin, but the source body is not known [1, 2].

29 samples were analysed by ICP-AES (major and minor elements) and ICP-MS (trace elements), among which are highly and slightly

enriched and non-enriched siliciclastic rocks, metavolcanics, and wall rock limestone. Geochemical data reveal, that the mobility of the trace elements during the process was different: light (L), medium (M) and heavy (H) REEs, as well as the other HFSEs enriched in various ratios in each of the rock bodies, furthermore, there are depleted elements, like Eu, Ti and P. To find regular patterns in the behaviour of elements and to identify samples affected by the enrichment process in similar mode, geostatistical methods were used. Factor analysis can reduce the dimensionality of the problem, while cluster analysis allows grouping based on the distance between the observations in the data space. Both rock samples and chemical elements can be clustered using this method. For the geostatistical analyses log transformed data were used. Elements were selected based on their mobility during the enrichment process. The analyses were done with MatLab.

The results of factor and cluster analyses are consistent with the graphical observations based on chondrite-and upper crust normalized spider plots, and with the correlation coefficients of the elements [2]. LREEs, MREEs and HREEs are responsible for explaining a larger proportion of the variance for different factors, while depleted elements are the main affecting agents in case of other factors. The behaviour of Zr is closest to that of LREEs, and that of Y to HREEs, while Nb, Ta and Th behaves differently.

Cluster analyses of samples were made based on the original chemical data and on the factors resulted from factor analysis. The second option is more efficient in grouping, as samples with similar HFSE mineralogy (e.g. with REE-Nb-oxide minerals) are placed into common groups. Non-enriched limestone is well separated. The result of clustering hardly depends on the original rock type, suggesting that the mobility of the HFSEs is the main controlling factor.

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Remote Sensing Techniques for Mineral Prospecting in Ariab Area, Red Sea Hills, NE Sudan

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Applied

The study area lies in the Red Sea Hills region of NE Sudan and occupies a central position in the Nubian segment of the late Proterozoic Pan-African Nubian-Arabian Shield. The Red Sea Hills have received considerable studies in structural and remote sensing aspects. Most of the studies were conducted to understand the structural evolution and the tectonic events of the Nubian- Arabian Shield in northeast Sudan. However, the link between the structural elements and the mineralization zones in the area is not well established. Therefore, the present study is concerned mainly with the determination of mineralization zones and highlighting the structural elements of the study area. Digital image processing of Landsat 8 OLI image enhanced areas that are rich in hydrothermally altered rocks, judging by their characteristic spectral signals. The mapped alteration zones were verified with the aid of the obtained field data. Subsequent chemical analysis using AAS revealed the presence of gold in the collected samples from the area. The structural analysis of brittle deformation manifestations revealed that the NE–SW fracture system represents the main controlling structure on the mineralization in the study area. This fractured system is crosscut by NW-SE trend and N-S structures. The outcome of the present study revealed the alteration zones and the structural controls on mineralization. However, further detailed studies are needed, where more samples are to be collected for geochemical analysis to verify the investigated area's mineral potentiality.

„Heavy mineral analysis" a useful method for the identification of the provenience of the archaeological tools made of calcareous sandstone

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Theoretical

Heavy mineral analysis (HMA) is one of the most important, sensitive and widely-used technique in the determination of sand and sandstone provenience. The combination of whole-rock petrographic informations, such as feldspar composition or quartz types with the heavy mineral data provide details on the mineralogical nature of the source areas. A wide variety of detrital heavy minerals has been found in sandstones, for example over 50 translucent detrital minerals were described by Mange & Maurer (1992) and in addition there are several opaque species of common occurrence.

Sandstones have been used for different types of stone tools (e.g. grinders, hammer- or mill stones), making of moulds or building stones throughout human history. This material is a very widespread rock type in the Carpathian-Pannonian region, and it may have got a very diverse composition. The petrographic and geochemical analysis of these tools is an emerging scientific field (e.g. Antonelli & Lazzarini 2010, Martínez-Sevilla et al. 2020, Péterdi 2020). However, HMA analysis in archaeometrical studies is a new, neglected method. The aim of this work is to present a complex petrographic and heavy mineral analysis of sandstones with carbonate cement sandstones from different sites, from the Copper- and the Bronze Age: Balatonendréd, Balatonszentgyörgy, Perkáta and Sármellék.

Heavy minerals are occurred in small amounts (generally less than 1%) in sandstones, still they mostly analysed in thin sections therefore the results are not representative in general because these sections represent only a small volume of the whole rock. Therefore, we use another possibility: we take a sample from the tool, disaggregate to liberate individual grains, dissever the grains with 63-250 μm in diameter and separate the heavy mineral fraction by high-density

liquid (natrium-polythungustate). With the separation of the heavy minerals the results will be more representative, because we can analyse at least 200-300 mineral grains in each samples. In this study we compare the HMA data which were got by thin section description with separate heavy mineral analysis. We can complete this method with petrographic and whole-rock geochemical analysis, moreover we can examine the heavy mineral composition with geochemical methods (e.g. SEM-EDX or SEM-WDX) and Raman spectroscopy. These methods together give us the best possibility to determine the provenience of the tools made of sandstone.

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