Description of courses included in the program on Natural and anthropogenic processes in the lithosphere and hydrosphere

Title and code of the course: **TPGE0001_EN Applications of GIS in Earth Sciences**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The aim of the course is to provide a general introduction to geoinformatics. During the seminar, students will learn about the theoretical and practical background of geoinformatics and its various applied methods. Through the use of various software programs, they will become familiar with the main procedures and areas of application.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. Patrick McHaffie, Sungsoon Hwang, Cassie Follett GIS An Introduction to Mapping Technologies, Second Edition ISBN 9781032308975 2. Kang-tsung Chang 2019, Introduction to Geographic Information Systems ISBN 9781260920710	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she is able to overview the field of GIS using the modern computer-aided technologies - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study b) Ability - He/she is able to plan and implement new projects, conduct research in a given field of science, and develop new techniques and approaches - He/she is able to choose and transform the datatypes and datasets necessary to answer the scientific questions, is able to apply the attained methods and analyses - He/she is able to adequately evaluate the calculated results and utilize them in the investigation of spatial social processes c) Attitude - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable - He/she endeavours to explore the spatial social phenomenon circumspectly and analytically - He/she endeavours to integrate and broadly utilize the adopted methods during the own work d) Autonomy and responsibility - He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions - He/she knows the limits of the adopted methods and applies them responsibly during the professional works	

Professor responsible for the course: Dr. Gergely Szabó, associate professor, PhD habil,
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1002_EN Environmental Geology**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The subject is introduced by a general presentation of the practical issues most closely related to doctoral research topics and their classification by scientific field. The most important areas of interest include cases of environmental geological problems related to mining, pollution sensitivity, land use and water source protection, examples of prevention, remediation and reclamation, construction safety issues of unstable terrain and the assessment of geopotential opportunities, and the examination of environmentally friendly and alternative energy supply options.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
Foley, D. et al. 2009: Investigations in environmental geology, Prentice Hall, Upper Saddle River N.J. Reichard, J.S. 2009: Environmental Geology. McGraw-Hill	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she has research-level knowledge of the subject area, general and specific characteristics, key trends, and precisely defined boundaries of the given field of science, as well as its agreed and disputed connections. - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability - He/she is able to creatively analyze a given field, formulate comprehensive and specialized connections in a synthetic, novel way, and evaluate and critique them appropriately. - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field. c) Attitude - He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation. - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable. d) Autonomy and responsibility - He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions. - He/she is able to participate in the formulation of theoretical and practical issues in a leading role and with a high level of cooperation. - He/she is able to act as an equal discussion partner with experts in the field.	

Professor responsible for the course: Dr. Árpád Csámer, assistant professor, PhD

Title and code of the course: **TPGE1003_EN Environmental geochemistry**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
Students will become familiar with instrumental analytical methods commonly used in geochemistry, as well as sampling techniques based on various indicators from different media (such as water, soil, minerals, ores, etc.), taking into account environmental interactions. The course will then present the methodology for sample preparation, focusing on the analytical investigation of the sample types listed above. The next step involves selecting the most appropriate analytical method for characterizing the material system in question, along with a general overview of its theoretical background and practical application. The course also covers the enrichment and migration properties of elements and compounds, as well as their impact on human health and the environment across various systems. Finally, we will analyze trends in the effects of essential and toxic contaminants influencing the quality of plants and food products in Hungary over the past decades.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
Foley, D. et al. 2009: Investigations in environmental geology, Prentice Hall, Upper Saddle River N.J. US. EPA 2007: Introduction to Environmental Geophysics (165.20) Student Manual White, W.M. 2007: Geochemistry. John Hopkins University Press.	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she has research-level knowledge of the subject area, general and specific characteristics, key trends, and precisely defined boundaries of the given field of science, as well as its agreed and disputed connections. - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability - He/she is able to creatively analyze a given field, formulate comprehensive and specialized connections in a synthetic, novel way, and evaluate and critique them appropriately. - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field. c) Attitude - He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation. - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable. d) Autonomy and responsibility - He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions.	

- He/she is able to participate in the formulation of theoretical and practical issues in a leading role and with a high level of cooperation. - He/she is able to act as an equal discussion partner with experts in the field. - He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession.

Professor responsible for the course: Dr. Árpád Csámer, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1005_EN Hydrodynamic modelling**	ECTS credit points: 2

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade:

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course

The task, stages, and objectives of modeling. Definition of a model. The laws governing the movement of water in porous media, the basic equation of seepage. Analytical and numerical solutions. Finite element and finite difference models. Deterministic and stochastic models. The basic data system for model calculations. Model structure, geometry definition. Boundary conditions, initial values. Introduction to the Processing MODFLOW for Windows environment. The most important Modflow packages. Running permanent and transient models. Model calibration, validation. Results of modeling typical hydrodynamic issues. Moving on to transport models.

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

Compulsory:
Fetter, CW. (2014): Applied Hydrogeology, Pearson, ISBN 13: 978-1-292-02290-1
Chiang, W.H. – Kinzelbach, W. (2003): 3D-Groundwater Modeling with PMWIN A Simulation System for Modeling Groundwater Flow and Pollution, Springer, ISBN 978-3-662-05551-9

Recommended:
Diersch, H-J. W. (2014): FEFLOW – Finite Element Modeling of Flow, Mass and Heat Transport in Porous and Fractured Media, Springer, ISBN: 978-3-642-38738-8
Ward, A. D. – Trimble, S. W. (2003): Environmental Hydrology, Lewis Publishers, ISBN: 9780429129940

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge
- Has research-level knowledge of the subject area, general and specific characteristics, most important trends, and precisely defined boundaries of the given scientific field, as well as its agreed and disputed connections.
- Possesses the research methodology knowledge necessary for hydrodynamic modelling.
- Knows the advantages and disadvantages of different types of numerical techniques.

b) Ability
- Able to creatively analyze a given field, formulate comprehensive and specific connections in a synthetic, novel way, and evaluate and critique them appropriately.
- Able to select the appropriate modeling method for the problem under investigation and perform the modeling.
- Able to interpret the results obtained and incorporate them into water management tasks.

c) Attitude
- Characterized by solid professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.
- Possesses the interest and learning ability necessary to solve even the most complex problems.
- Is open to understanding and solving water management problems at the system scale.

d) Autonomy and responsibility
- Able to participate in the formulation of theoretical and practical issues with a leading role and a high level of cooperation.
- Independently creates and analyzes models related to hydrogeology.

- Supports climate adaptation with appropriate data analysis methods.

Professor responsible for the course: Dr. Tamás Buday, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1007_EN Radiometric age determination**	ECTS credit points: 2

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade:

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course

In the framework of the course, the doctoral student will get acquainted with the history of geochronology, the physical laws of radiometric decay and decay series. The sample preparation methods and analytical methods necessary for dating are presented. He/she will learn the basics of mass spectrometry and vacuum technology. Acquire detailed knowledge of K/Ar, Ar/Ar, U/Pb, Rb/Sr, 14C, Rb/Sr and Sm/Nd dating. He/she learns about the possibilities and limitations of these methods, as well as the possibilities of interpreting the results in different geological models. In practice, he performs the dating of a sample himself.

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

1. Geyh M. A. , Schleicher H. (1990): Absolute Age Determination. Springer Verlag, Berlin ISBN-13: 978-3-540-51276-9
2. Gross J. H. (2017): Mass spectrometry. Springer Verlag Heidelberg 1-919. ISBN 978-3-319-54397-0
3. Gopalan K. (2017): Principles of Radiometric Dating. Cambridge University Press 1-207. ISBN 978-1-107-19873-9
4. Reiners et al. (2018): Geochronology and Thermochronology. John Wiley and Sons Ltd. ISBN 978-1-118-45585-2
5. Jourdan F. (2014): Advances in 40Ar/39Ar Dating: From Archaeology to Planetary Sciences Geological Society, London, Special Publications Volume 378 Pages 1 -8

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge
- He/she understands the connections and theories of geochronology and the development of the earth's crust in a creative way, as well as the conceptual systems and terminology that make them up.
- He/she has the research methodological knowledge necessary for the independent research of geochronology.
- He/she is able to identify unforeseen geochronological problems and to explore the detailed theoretical and practical background necessary for solving them at the research level.
- He has an interest and the ability to learn that allows him to identify and solve the currently opaque and unpredictable research problems of geochronology.

b) Ability
- His characteristic attitude is a firm professional commitment, the perpetuation of the dedication to find new paths, and the acceptance of the need for persistent work.
- With a leading role and a high level of cooperation, he/she is able to participate in the formulation of theoretical and practical geochronological questions.

c) Attitude
- He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable.
- He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.

d) Autonomy and responsibility

- He/she is able to act as an equal discussion partner with experts in the field. - He is able to play an equal role as a discussion partner with the experts of geochronology and geology.

Professor responsible for the course: Dr. Zsolt Benkó, associate professor, PhD, habil.
Lecturers involved in teaching the course, if relevant: Dr. Kata Molnár, senior research fellow, PhD, Dr. Mihály Molnár, senior research fellow, PhD

Title and code of the course: **TPGE 1009_EN Magmatic Petrogenesis**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
Within the scope of this subject, after presenting (1) the relationship between magmatism and plate tectonics as an introductory part, we will deal in detail with (2) the geochemistry of igneous rocks as petrogenetic indicators; (3) the processes modifying the composition of primary magma; (4) the petrogenetics of magmatism at accreting plate margins (mid-ocean ridges), (5) subducting plate margins (island arcs, active plate margins, back-arc basins), and (6) within-plate (oceanic islands, continental basalt troughs, and continental rift zones).	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. Wilson, M.: Igneous magmagenesis. A global tectonic approach. 2007. eBook ISBN978-1-4020-6788-4 2. DA – Dobson, KJ – Morgan, DJ – Pankhurst, MJ: The Petrogenesis of Magmatic Systems: Using Igneous Textures to Understand Magmatic Processes. In: Burchardt, S (ed): Volcanic and Igeneous Plumbing System. Chapter 8. Elsevier, ISBN: 978-0-12-809749-6)	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge: - He/she has knowledge of the general and specific characteristics of igneous rocks, are aware of their formation processes, recognize the connections between their geographical occurrence and plate tectonic position, and have research-level knowledge. - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability: - He/she is able to creatively develop novel, previously unknown practical applications of theoretical issues. - He/she is able to plan and implement new projects, conduct research in a given field of science, and develop new techniques and approaches. - He/she is able to identify unforeseen professional problems and explore the detailed theoretical and practical background necessary to solve them at the research level. c) Attitude: He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable. - He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work. d) Autonomy and reponsibility: - He/she is able to act as an equal discussion partner with experts in the field. - He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession.	

Professor responsible for the course: Dr. Péter Rózsa, r. associate professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1011_EN Basin analysis in raw-material research**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
Identification of sedimentary facies in outcrops, cores and wireline log interpretations. Analysis of cycles in sedimentary successions: recognition of cycles, correlation of them, formation of stratigraphic model. Facies characteristics of sedimentary systems tracts and the related raw materials. Fluvial deposits as basin fill successions. Stratigraphic interpretation of fluvial successions and its importance in hydrogeological models. Optimal workflow of database development in subsurface geological mapping, the role of stratigraphic model, advancements and limitations.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
3. Posamentier, H.W., Allen, G.P., 1999. Siliciclastic sequence stratigraphy — concepts and applications. SEPM No. 7 204 p. 4. Bridge, J.S., 2003. Rivers and Floodplains. Blackwell Publishing, Oxford.	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she is able to identify elementary cycles in sedimentary successions. b) Ability - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field c) Attitude - He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work - He/She is abe to support the solving of practical problems by his/her sedimentological knowledge d) Autonomy and responsibility - He/she is able to act as an equal discussion partner with experts in the field. - He/she is able interpret the development of a sedimentary succession	

Professor responsible for the course: Dr. Zoltán Püspöki, Senior research fellow, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1016_EN Micro- and morphotectonics**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The students will deal with the deformations of rocks of different ages and consistencies from different tectonic settings. Also, with problems, limitations and potentials of measuring and figuring such deformations. Relationships of position, orientation, shape of structural morphological units and tectonic processes are analysed based on examples from North Hungary. Possibilities regarding the separation and reconstruction of disharmony, the traces and phenomena of stress field interference and overprinting are discussed. Analysis of model study areas and mapping possibilities are presented.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
5. Fossen, H. 2016. Structural geology. Cambridge University Press, Cambridge, 528 p. 6. Scheidegger, A.E. 2004: Morphotectonics. Springer, Berlin – Heidelberg, 197 p.	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she is able to identify complex structural elements. b) Ability - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field c) Attitude - He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work - He/She is abe to support the solving of practical problems by his/her tectonic knowledge d) Autonomy and responsibility - He/she is able to act as an equal discussion partner with experts in the field.	

Professor responsible for the course: Dr. Richard William McIntosh, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1017_EN Applying thermal analysis**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
This instrumental analytical method can be widely used in solving classical, applied, and environmental geological tasks. The method is very sensitive for detecting the order state of minerals and the substitutions appearing in them, and is also suitable for quantitative evaluation in phase analysis. It can be used well in the genetic analysis of hydrothermal and weathering processes, as well as the components of sedimentary rock facies, and in raw material research. When examining the construction safety of unstable complexes, the sensitivity of vulnerable environments to pollution, and the ion exchange and swelling capacity of soil constituents, it provides an opportunity to characterize the properties through the quantitative and qualitative determination of clay mineral content. It is suitable for detecting amorphous phases that are less easily examined by X-ray diffraction, which may have a significant adsorption role in nature. The basic concepts and methods of thermal analysis are presented in the course of the subject; thermal decomposition processes of mainly heat-sensitive minerals, the possibilities of examining the types of water binding related to their structure, quantitative phase analyses of certain types of rocks, soils, mineral paragenesis, as well as special procedures (treatments, tests in a gas atmosphere, determination of corrected decomposition temperature, reaction kinetic measurements, etc.).	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
Brown, M.E. 2004: Introduction to Thermal Analysis Techniques and Applications. Kluwer Academic Publishers, Print ISBN: 1-4020-0472-9 Földvári, M. 2011: Handbook of the thermogravimetric system of minerals and its use in geological practice. Occasional Papers of the Geological Institute of Hungary, vol. 213, Budapest, 180 p.	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she has research-level knowledge of the subject area, general and specific characteristics, key trends, and precisely defined boundaries of the given field of science, as well as its agreed and disputed connections. - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability - He/she is able to creatively analyze a given field, formulate comprehensive and specialized connections in a synthetic, novel way, and evaluate and critique them appropriately. - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field. c) Attitude - He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation. - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable.	

d) Autonomy and responsibility

- He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions.
- He/she is able to participate in the formulation of theoretical and practical issues in a leading role and with a high level of cooperation.
- He/she is able to act as an equal discussion partner with experts in the field.
- He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession.

Professor responsible for the course: Dr. Árpád Csámer, assistant professor, PhD

Title and code of the course: **TPGE1018_EN Historic building materials**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The subject is divided into three large chapters. The first topic provides a historically focused description of the use, production and utilization of historical building materials (stone, mortar, brick, etc.), a presentation of their basic and raw materials, and an overview of historical building materials. The second part deals with the standard (based on MSZ EN standards) and non-standardized petrographic and geochemical examination methods of historical building materials, partly with a theoretical and partly with a practical presentation. The third part presents the damage processes of building materials, through several case study examples. All three parts emphatically address the examination, restoration and provenance investigation issues of historical building materials in Hungary.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. Davey, N: A History of Building Materials. Phoenix House, London, 1961. 2. Loyd Thomas, K.: Building Materials: Material Theory and the Architectural Specification. Bloomsbury, London, 2021. 978-1-3501-7623-2 (epdf)	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge: - He/she has knowledge of the general and specific characteristics of historical building materials, recognition of the geographical context of their use, and research-level knowledge. - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability: - He/she is able to creatively develop novel, previously unknown practical applications of theoretical issues. - He/she is able to plan and implement new projects, conduct research in a given field of science, and develop new techniques and approaches. - He/she is able to identify unforeseen professional problems and explore the detailed theoretical and practical background necessary to solve them at the research level. c) Attitude: He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable. - He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work. d) Autonomy and reponsibility: - He/she is able to act as an equal discussion partner with experts in the field. - He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession.	

Professor responsible for the course (*name, position, academic degree*): Dr. Péter Rózsa, r. associate professor, PhD
Lecturers involved in teaching the course, if relevant (*name, position, academic degree*):

Title and code of the course: **TPGE1024_EN Physical volcanology**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The aim of this course is to provide students with fundamental knowledge about volcanism, a process that has continuously shaped our planet throughout its history. Volcanic activity has significantly influenced the geological development of the Carpathian Basin, albeit with varying intensity over time. This course primarily focuses on the processes of physical volcanology to explain the formation and morphology of volcanic mountains. Topics covered in the course include: - Formation of magma in different plate tectonic environments - Types of volcanic formations: stratovolcanoes, calderas, lava domes, etc. - Eruption types, including the Volcano Explosivity Index (VEI), Strombolian, Hawaiian, and Plinian eruptions - Volcanic materials, such as lava rocks, pyroclastic rocks, and lahar deposits - Hydrothermal systems and volcanic raw materials - Volcanic hazards - The role of volcanism in the Carpathian Basin - Field methods used in volcanology. -Volcanic geotourism in active areas and the Carpath-Pannonian Region	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. Cas R., Giordano G., & Wright J.V. 2024. Volcanology. Processes, deposits, geology and resources' published by Springer. Cambridge University Press. 2. Schmincke H-U. .Volcanism. Springer-Verlag, Berlin, Heidelberg, New York. 401p. 3. 3. Németh K., Martin U., Practical Volcanology, Occasional Papers of the Geological Institute of Hungary, Budapest, 2007, 207, 1–221. 4. 4. Sigurdsson H., Houghton B., McNutt S., Rymer, H., Stix J. (Eds.), eds 2015 The Encyclopedia of volcanoes 2nd edition Academic Press, USA. 1456 p. 5. Erfurt-Cooper, P. Volcanic Tourist Destinations; Springer Science & Business Media: Berlin, Germany, 2014; p. 379	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - Understand the fundamentals of volcanic processes, including magma generation, eruption mechanisms, and the properties of volcanic materials. - Comprehend the relationships between tectonic settings and volcanic activity, with a focus on divergent, convergent, and intraplate volcanoes. b) Ability - Analyze volcanic data and interpret physical observations from eruptions, lava flows, and tephra deposits - Apply field-based techniques to observe and document volcanic landforms, making accurate inferences about their formation processes. c) Attitude - Recognize the impact of volcanic activity on ecosystems, human populations, and infrastructure, fostering a sense of responsibility toward environmental conservation. - Appreciate the importance of teamwork in field studies, data collection, and collaborative research efforts in volcanology. d) Autonomy and responsibility - Creatively interpret volcanic successions utilizing available datasets and field observations.	

- Contribute to the course community by sharing ideas, discussing volcanic case studies, and providing constructive feedback to peers.

Professor responsible for the course: Dr. János Szepesi, Senior research fellow, PhD, habil
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1026 Advanced analytical methods in geochemistry**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
In the course the student can get acquainted with the theoretical foundations and practical applications of modern analytical methods used to determine the main and trace elements of rocks and their minerals, as well as their stable and radiogenic isotope ratios. Methods included in the course: atomic spectroscopy methods (AAS and ICP-OES), XRF, mass spectrometry, ICP-MS, laser ablation ICP-MS, electron microprobe, ion probe, and nuclear analytical methods (proton microprobe). In addition to the lectures, there is also an opportunity to learn about certain methods in practice. We will also talk about the processing, representation and geological interpretation of the data obtained.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. Rollinson H. (1993): Using geochemical data. Pearson Education Asia, Singapore 1-340. 2. Gross H. J. (2017): Mass spectrometry. Springer Nature, ISBN 978-3-319-54397-0 3. Johnson E., Liu, C. J.: https://viva.pressbooks.pub/analyticalmethodsingeosciences/	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she has the research methodological knowledge necessary for the independent use of instrumental material testing methods used in geological exploration. - He/she is able to plan and implement the analytical analysis of new geological samples, to carry out research in the field of geochemistry, and to develop new techniques and approaches. - He/she is able to identify unforeseen analytical tasks and to explore the detailed theoretical and practical background necessary for solving them at the research level. b) Ability - With creative independence, he builds and initiates new areas of knowledge and initiates new practical solutions in the field of geochemistry. c) Attitude - With a leading role and a high level of cooperation, they are able to participate in the formulation of theoretical and practical geochemical questions.	

Professor responsible for the course: Dr. Zsolt Benkó, associate professor, PhD, habil,
Lecturers involved in teaching the course, if relevant: Dr. Molnár Kata PhD, Research fellow, PhD Dr. Temovski Marjan, lecturer, PhD

Title and code of the course: **TPGE1030_EN Astrogeology and Cosmochemistry**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The course covers the main and minor objects of the Solar System, including planets, moons, comets, asteroids, and dwarf planets. During the lectures, students will learn about the purpose of cosmochemistry and cosmogenic dynamics, nucleosynthesis, the theory of the formation of the Solar System and the laws operating in it, the material evolution of planets and other celestial bodies, meteorites, the geology and geography of impact structures, and the effects of cosmic catastrophes on terrestrial systems. The astrogeology, or so-called exogeology, is one of the most progressive interdisciplinary subjects of earth and planetary science. During the course, the main features of terrestrial planets, gas and icy giants, and their moons, as well as the evolution of their surfaces, are reviewed. The evolution, geochemical properties, and rock types of the Moon are also introduced. Main types, characteristics of extraterrestrial rock, and their analytical methods are all discussed.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
Faure, G, Mensing, T.M. 2007: Introduction to Planetary Science, The Geological Perspective. Springer Barlow, N. 2008: Mars: An Introduction to its Interior, Surface and Atmosphere. Cambridge University Press Vita-Finzi, C. 2013:Planetary Geology: An Introduction. Dunedin Academic Press Ltd Heinrich D. Holland and Karl K. Turekian, 2014: Treatise on Geochemistry (Second Edition), Volume 1, Elsevier Ltd.	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she has research-level knowledge of the subject area, general and specific characteristics, key trends, and precisely defined boundaries of the given field of science, as well as its agreed and disputed connections. - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability - He/she is able to creatively analyze a given field, formulate comprehensive and specialized connections in a synthetic, novel way, and evaluate and critique them appropriately. - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field. c) Attitude - He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation. - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable. d) Autonomy and responsibility	

- He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions.
- He/she is able to participate in the formulation of theoretical and practical issues in a leading role and with a high level of cooperation.
- He/she is able to act as an equal discussion partner with experts in the field.
- He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession.

Professor responsible for the course: Dr. Árpád Csámer, assistant professor, PhD

Title and code of the course: **TPGE1031_EN Potential of geothermal reservoirs**	ECTS credit points: 2

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade:

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course

The course provides an overview of the forms of geothermal energy, geothermal reservoirs, different reservoir classifications related to geothermal energy, their categories and characteristics, and the possibilities for interpreting geothermal potential (e.g., surface heat flux density, volumetric energy density; McKelvey classification, Rybach classification). Students will learn about the sources of geological and other data related to the calculation of potential, the consequences of data uncertainty and ways of dealing with it, and gain insight into analytical, numerical, and analogy-based calculation methods. The course concludes with a theoretical and practical presentation of the representation of the results obtained in graphs and maps.

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

Compulsory:
Stober, I. – Bucher, K. (2013): Geothermal Energy. From Theoretical Models to Exploration and Development, Springer, 291 p., ISBN: 978-3-030-71684-4
Eppelbaum, L. – Kutasov, I. – Pilchin, A. (2014): Applied Geothermics, Springer, 751 p., ISBN: 978-3-642-34022-2

Recommended:
Pasquale, V. – Verdoya, M. – Chiozzi, P. (2014): Geothermics. Heat Flow in the Lithosphere, Springer, 119 p., ISBN: 978-3-319-02510-0
Watson, A. (2013): Geothermal Engineering. Fundamentals and Applications, Springer, 336 p., ISBN: 978-1-4614-8568-1
Ochsner, K. (2007): Geothermal Heat Pumps. A Guide for Planning and Installing, Earthscan, 146 p., ISBN: 978-1-8497-7144-3

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge
- Has research-level knowledge of the subject area, general and specific characteristics, most important trends, and precisely defined boundaries of the given scientific field, as well as its agreed and disputed connections.
- Possesses the research methodology knowledge necessary to assess the possibilities of geothermal energy utilization.
- Is familiar with the calculation methods for different types of geothermal potential, as well as the advantages and disadvantages of these methods.

b) Ability
- Able to creatively analyze a given field, formulate comprehensive and specific connections in a synthetic, novel way, and evaluate and critique them appropriately.
- Able to select the appropriate calculation method for the problem under investigation, perform the calculation, and determine its uncertainty.
- Able to interpret the results obtained and incorporate them into energy management tasks.

c) Attitude

- Characterized by solid professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.
- Possesses the interest and learning ability necessary to solve even the most complex problems.
- Is open to understanding and solving national and local energy management problems at the system scale.

d) Autonomy and responsibility

- Able to participate in the formulation of theoretical and practical issues with a leading role and a high level of cooperation.
- Independently analyzes geothermal systems.
- Assists climate adaptation with appropriate geothermal potential calculations.

Professor responsible for the course: Dr. Tamás Buday, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1032_EN Introduction to meteoritics**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
Within the framework of the course, students will gain insight into the main types of meteorites, as well as their chemical and mineralogical composition. Modern analytical techniques used to examine the mineralogical structure of meteorites will be introduced, along with their theoretical foundations. The course places particular emphasis on the characteristic mineral components of carbonaceous chondrites, but lunar rock and soil samples, as well as meteorites originating from Mars, will also be discussed. In addition, students will learn about the internal structure and formation of the potential parent bodies of meteorites.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
O. Richard Norton and Lawrence A. Chitwood, 2008: Field Guide to Meteors and Meteorites. Springer-Verlag London Limited, ISBN 978-1-84800-156-5 Heinrich D. Holland and Karl K. Turekian, 2014: Treatise on Geochemistry (Second Edition), Volume 1, Elsevier Ltd.	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she has research-level knowledge of the subject area, general and specific characteristics, key trends, and precisely defined boundaries of the given field of science, as well as its agreed and disputed connections. - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability - He/she is able to creatively analyze a given field, formulate comprehensive and specialized connections in a synthetic, novel way, and evaluate and critique them appropriately. - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field. c) Attitude - He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation. - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable. d) Autonomy and responsibility - He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions. - He/she is able to participate in the formulation of theoretical and practical issues in a leading role and with a high level of cooperation. - He/she is able to act as an equal discussion partner with experts in the field.	

- He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession.

Professor responsible for the course: Dr. Árpád Csámer, assistant professor, PhD
Lecturers involved in teaching the course, if relevant:-

Title and code of the course: **TPGE1033_EN Analysis of hydrological data**	ECTS credit points: 2

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade:

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course

Hydrological and hydrometeorological data and processes affecting their values, the water cycle. Designation of a network of measuring stations, analysis of the existing network, overview of domestic measuring networks. Measurement and representation of hydrological and hydrometeorological data in various types of diagrams, descriptive statistics. The most important distributions of discrete and continuous hydrological and hydrometeorological variables. Theory and practice of correlation and regression calculations, time series analyses (trend analysis, autocorrelation, cross-correlation, frequency analysis) in the field of hydrology. Spatial interpretability of results. Possibilities for applying machine learning methods in data analysis, with special regard to hydrology.

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

Compulsory:
Fetter, CW. (2014): Applied Hydrogeology, Pearson, ISBN 13: 978-1-292-02290-1
Hipel KW. – McLeod A.I. (1994): Time series modellig of water resources and environmental systems, Elsevier, ISBN: 0–444–89270-2

Recommended:
Remesan, R. –Mathew, J. (2015): Hydrological Data Driven Modelling – A Case Study Approach, Springer, ISBN 978-3-319-09234-8
Kirchgässner, G. – Wolters, J. (2007): Introduction to Modern Time Series Analysis, Springer, ISBN 978-3-540-73290-7

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge
- Has research-level knowledge of the subject area, general and specific characteristics, most important trends, and precisely defined boundaries of the given scientific field, as well as its agreed and disputed connections.
- Possesses the research methodology knowledge necessary for analyzing hydrological data sets.
- Is familiar with the most important methods of applying artificial intelligence to hydrology.

b) Ability
- Able to creatively analyze a given field, formulate comprehensive and specific connections in a synthetic, novel way, and evaluate and critique them appropriately.
- Able to select measurement and evaluation methods appropriate to the problem under investigation.
- Able to use the relevant methods of machine learning.

c) Attitude
- Characterized by solid professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.
- Possesses the interest and learning ability necessary to solve even the most complex problems.
- Is open to understanding and solving water management problems at the system scale.

d) Autonomy and responsibility

- Able to participate in the formulation of theoretical and practical issues with a leading role and a high level of cooperation.
- Independently creates and analyzes models related to hydrology.
- Supports climate adaptation with appropriate data analysis methods.

Professor responsible for the course: Dr. Tamás Buday, assistant professor, PhD
Lecturers involved in teaching the course, if relevant:-

Title and code of the course: **TPGE1034_EN Extraction of ambient heat with heat pump**	ECTS credit points: 2

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade:

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course

Recent trends in geothermal energy extraction. General structure of heat pump systems. Types of heat pumps based on the operation mode. Classifications by the type of primary and secondary loops. The economic and environmental impacts of heat pump systems, the temperature changes created, the primary energy required, and greenhouse gas emissions. Modeling and monitoring of heat pump systems. Factors influencing the dimensioning of heat pump systems. The role of geological, meteorological, and landscape conditions in the installation of heat pump systems, and methods for researching these. The installability of heat pump systems under Hungarian conditions.

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

Compulsory:

Stober, I. – Bucher, K. (2013): Geothermal Energy. From Theoretical Models to Exploration and Development, Springer, 291 p., ISBN: 978-3-030-71684-4

Banks, D. (2008): An Introduction to Thermogeology. Ground Source Heating and Cooling, Blackwell Publishing, 339 p., ISBN:978-0-4706-7034-7

Ochsner, K. (2007): Geothermal Heat Pumps. A Guide for Planning and Installing, Earthscan, 146 p., ISBN: 978-1-8497-7144-3

Recommended:

Pasquale, V. – Verdoya, M. – Chiozzi, P. (2014): Geothermics. Heat Flow in the Lithosphere, Springer, 119 p., ISBN: 978-3-319-02510-0

Watson, A. (2013): Geothermal Engineering. Fundamentals and Applications, Springer, 336 p., ISBN: 978-1-4614-8568-1

Eppelbaum, L. – Kutasov, I. – Pilchin, A. (2014): Applied Geothermics, Springer, 751 p., ISBN: 978-3-642-34022-2

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge
- Has research-level knowledge of the subject area, general and specific characteristics, most important trends, and precisely defined boundaries of the given scientific field, as well as its agreed and disputed connections.
- Possesses the research methodology knowledge necessary to assess the possibilities of geothermal energy utilization.
- Is familiar with the different types of heat pumps and their advantages and disadvantages.

b) Ability
- Able to creatively analyze a given field, formulate comprehensive and specific connections in a synthetic, novel way, and evaluate and critique them appropriately.
- Able to select the appropriate calculation method for the problem under investigation, perform the calculation, and determine its uncertainty.
- Able to interpret the results obtained and incorporate them into energy management tasks.

c) Attitude

- Characterized by solid professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.
- Possesses the interest and learning ability necessary to solve even the most complex problems.
- Is open to understanding and solving national and local energy management problems at the system scale.

d) Autonomy and responsibility

- Able to participate in the formulation of theoretical and practical issues with a leading role and a high level of cooperation.
- Independently analyzes heat pump related systems.
- Assists climate adaptation with understanding the role of heat pump systems.

Professor responsible for the course: Dr. Tamás Buday, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1037_EN Geology of Hungary**	ECTS credit points:
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The students will learn the models and most important questions related to the tectonic development of the Pannonian Basin. Bearing in mind this development, the geological conditions, the megastructural conditions and the age determination results of the igneous regions are analysed. Finally, the detailed geological settings and structural conditions of some selected regions are discussed.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. Haas, J. 2001: Geology of Hungary. ELTE, Budapest, 319 p. 2. Kocsis, K. 2018: National Atlas of Hungary – Natural Environment. MTA, CSFK Geographical Institute, Budapest, 183 p.	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she knows the geological conditions of Hungary b) Ability - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field c) Attitude - He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work d) Autonomy and responsibility - He/she is able to act as an equal discussion partner with experts in the field.	

Professor responsible for the course: Dr. Richard William McIntosh, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1041_EN Cyclostratigraphy**	ECTS credit points:
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
Definition and types of time series (continuous and discrete signal), the conditions of anyalysis, requirements of sample taking. Data management before spectral investigation (consideration of outliers, removal of average, detrending, pre-whitening). Primer methods of spectral analysis (Fourier transformation, Multi-taper, Blackman-Tukey, maximum entropy, and Walsh methods) and interpretation of the resulting spectrum. Complementary methods (filtering, wavelet analysis, eCOCO). Presentation of software developed for time series analysis (AnalySeries, Acycle).	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
3. Weedon, G. P. 2003: Time-Series Analysis and Cyclostratigraphy – Examining Stratigraphic Records of Environmental Cycles. 259 pp. Cambridge University Press, Cambridge.	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - He/she is able to extract regular cycles from a sedimentary succession b) Ability - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field c) Attitude - He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work d) Autonomy and responsibility - He/she is able to act as an equal discussion partner with experts in the field.	

Professor responsible for the course: Dr. Zoltán Püspöki, Senior research fellow, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1043_EN Mineralogy**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
Within the framework of the course, a more detailed understanding of minerals and mineral groups will be provided, which will help to better understand the physical and chemical characteristics of geological processes (pressure, temperature) and the mineralogical aspects of subsurface fluid flow. We discuss the mineralogical alterations of diagenetic processes, the mineralogical characteristics of hydrothermal ore systems, and the characteristic mineral paragenesis of the earth's mantle. We get acquainted with the rare mineral complexes and ore deposits of extraterrestrial planets and planetesimals. Special attention is paid to the structural geological aspects of clay minerals and the significance of heavy minerals in the determination of the deposition area.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. Meunier A., Velde B. (2004): Illite. Springer Verlag Berlin 1-286. ISBN 3-540-20486-5 2. Markl G. (2008): Minerale und Gesteine. Spektrum-Springer Verlag Tübingen 1-608. ISBN 978-8274-1804-3 3. Pirajno F. (2009): Hydrothermal Processes and Mineral Systems Springer Science Business Media B.V Perth ISBN: 978-1-4020-8612-0 4. Mange M.A., Maurer H. (1992): Heavy Minerals in Colour. Springer Science ISBN 978-94-010-5019-7 5. Worden H. R., Morad S. (2003) Clay mineral cements in sandstones. Blackwell Publishing 1-506. ISBN: 978-1-405-10587-3	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she has research-level knowledge of the general and specific characteristics, the most important directions and precisely developed boundaries of mineralogy, as well as the agreed and disputed relationships. - He/she is able to creatively elaborate novel, hitherto unknown practical aspects of theoretical issues. - He/she is able to plan and implement new mineralogical projects, conduct mineralogical research, and develop new techniques and approaches. - He/she is able to identify unforeseen mineralogical problems and to explore the detailed theoretical and practical background necessary for their solution at the research level. He/she is able to play an equal role as a discussion partner with the experts of the field of mineralogy. He or she is responsible for raising and answering new ethical questions in connection with the theoretical and practical issues of mineralogy. b) Ability - It represents and further develops the relations that contribute to the process of human self-creation due to the specificity of the field. c) Attitude - He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation. d) Autonomy and responsibility	

- He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions.

Professor responsible for the course: Dr. Zsolt Benkó, associate professor, PhD habil.
Lecturers involved in teaching the course, if relevant: Dr. Árpád Csámer, assistant professor, PhD

Title and code of the course: **TPGE1044_EN Exploring geothermal resources**	ECTS credit points: 2

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade:

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course

In this course, we will review the forms of geothermal energy and current trends in geothermal energy utilization. We will learn about geothermal reservoirs, different reservoir classifications related to geothermal energy, their categories, and characteristics. We will review the most important geophysical methods that are essential for delineating geothermal reservoirs (e.g., gravity, seismic, electromagnetic (CSAMT), well-log geophysics). We will examine the geochemical methods that can be used in geothermal research. We will learn about the steps involved in determining the characteristic properties of different types of reservoirs.

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

Compulsory:
Stober, I. – Bucher, K. (2013): Geothermal Energy. From Theoretical Models to Exploration and Development, Springer, 291 p., ISBN: 978-3-030-71684-4
Eppelbaum, L. – Kutasov, I. – Pilchin, A. (2014): Applied Geothermics, Springer, 751 p., ISBN: 978-3-642-34022-2

Recommended:
Pasquale, V. – Verdoya, M. – Chiozzi, P. (2014): Geothermics. Heat Flow in the Lithosphere, Springer, 119 p., ISBN: 978-3-319-02510-0
Watson, A. (2013): Geothermal Engineering. Fundamentals and Applications, Springer, 336 p., ISBN: 978-1-4614-8568-1
Ochsner, K. (2007): Geothermal Heat Pumps. A Guide for Planning and Installing, Earthscan, 146 p., ISBN: 978-1-8497-7144-3

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge
- Has research-level knowledge of the subject area, general and specific characteristics, most important trends, and precisely defined boundaries of the given scientific field, as well as its agreed and disputed connections.
- Possesses the research methodology knowledge necessary to assess the possibilities of geothermal energy utilization.
- Is familiar with the various types of geothermal research methods and their advantages and disadvantages.

b) Ability
- Able to creatively analyze a given field, formulate comprehensive and specific connections in a synthetic, novel way, and evaluate and critique them appropriately.
- Able to select the appropriate calculation method for the problem under investigation, perform the calculation, and determine its uncertainty.
- Able to interpret the results obtained and incorporate them into energy management tasks.

c) Attitude

- Characterized by solid professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.
- Possesses the interest and learning ability necessary to solve even the most complex problems.
- Is open to understanding and solving national and local energy management problems at the system scale.

d) Autonomy and responsibility

- Able to participate in the formulation of theoretical and practical issues with a leading role and a high level of cooperation.
- Independently analyzes geothermal systems.
- Assists climate adaptation with exploring appropriate geothermal reservoirs.

Professor responsible for the course: Dr. Tamás Buday, PhD, assistant professor
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1047_EN Geophysics**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
Subject of geophysics. Theoretical base of the geophysical methods and general steps of analysis of geophysical data. Physical base of gravity method, possibilities its applications, separation the regional and local anomalies. Physical base of seismic methods, possible applications of reflected and refracted waves. Magnetic and electrical field of the Earth, its temporal and spatial changes. Electromagnetic methods, base of vertical electric sounding, constant separation traversing, multielectrode arrays. Theoretical base of well-logging, borehole and its surrounding, connection to the surface geophysical surveys, the most important logs. Complex geophysical surveys, the position of the geophysics in the researches in the field of structure geology, mineral resources, engineering geology and environmental geology.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
Compulsory: Musset, A. E. – Khan, A. E. (2009): Looking into the Earth. An introduction to geological geophysics. – Cambridge University Press, 470 p., ISBN: 978-0-521-78085-8 Reynolds, J. M. (2011): An introduction to applied and environmental geophysics. – WileyBlackwell, 696 p., ISBN: 978-0-471-48535-3 Recommended: Ellis, D. V. – Singer, J. M. (2008): Well logging for Earth Scientists. – Springer, 692 p., ISBN: 978-1-4020-3738-2 Asquith, G. – Krygowski, D. (2004): Basic Well Log Analysis. – AAPG Methods in Exploration Series, No. 16, AAPG, Tulsa, 244 p., ISBN: 978-0-8918-1667-6 Gadallah, M. R. – Fisher, R. (2009): Explorational geophysics. An Introduction. – Springer, 262 p., ISBN: 978-3-540-85159-2	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - Has research-level knowledge of the subject area, general and specific characteristics, most important trends, and precisely defined boundaries of the given scientific field, as well as its agreed and disputed connections. - Knows the possible purposes and methods of applying geophysical research. - Knows the advantages and disadvantages of different geothermal research methods. b) Ability - Able to creatively analyze a given field, formulate comprehensive and specific connections in a synthetic, novel way, and evaluate and critique them appropriately. - Able to select measurement and evaluation methods appropriate to the problem under investigation. - Able to interpret the results obtained and draw geological conclusions from them. c) Attitude - Characterized by solid professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.	

- Possesses the interest and learning ability necessary to solve even the most complex problems.
- Is open to the use of geophysical measurements.

d) Autonomy and responsibility

- Able to participate in the formulation of theoretical and practical issues with a leading role and a high level of cooperation.
- Independently analyzes geophysical data.

Professor responsible for the course: Dr. Tamás Buday, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1051_EN Cave sediments**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The course aims to provide an in-depth understanding of the sediments found in caves, both clastic and chemical (i.e., cave minerals/speleothems). Caves represent a sediment trap and provide an opportunity to obtain information on past changes that has been lost from the surface due to erosion. This makes cave sediments very useful to reconstruct landscape evolution, paleoclimate, animal and human evolution. As a result, cave sediments have been the focus of interest to various disciplines (geology, geomorphology, paleontology, paleoclimatology, archeology etc). During the course, the students will become familiar with the clastic cave sediments which are variable on grain size (clay, silt, sand, gravel), mineral composition, origin and age. They will learn about the diversity of cave minerals and their morphological expressions (e.g., speleothems). The students will get better understanding of the specifics of the cave depositional environment, and the applied methodological approaches.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. De Waele, J., Gutierrez, F., 2022. Karst Hydrogeology, Geomorphology and Caves, First edition. John Wiley & Sons. https://doi.org/10.1002/9781119605379 2. Hill, C.A., Forti, P., 1997. Cave Minerals of the World. National Speleological Society, Huntsville, AL 3. Fairchild, I.J., Baker, A., 2012. Speleothem Science: From Process to Past Environments, Wiley-Blackwell, Chichester 4. Zupan Hajna, N., Bos´ak, P., Pruner, P., Mihevc, A., Hercman, H., Hor´aˇcek, I., 2020. Karst sediments in Slovenia: Plio-Quaternary multi-proxy records. Quat. Int. 546, 4–19. https://doi.org/10.1016/j.quaint.2019.11.010 5. Temovski, M., Wieser, A., Marchhart, O., Braun, M., Madarász, B., Kiss, G.I., Palcsu, L., Ruszkiczay-Rüdiger, Z., 2024. Pleistocene valley incision, landscape evolution and inferred tectonic uplift in the central parts of the Balkan Peninsula – Insights from the geochronology of cave deposits in the lower part of Crna Reka basin (N. Macedonia). Geomorphology 445, 108994. https://doi.org/10.1016/j.geomorph.2023.108994	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she creatively understands the connections, theories, and conceptual systems and terminology applied in the study of cave sediments - He/she possesses the research methodology knowledge necessary for independent research on clastic sediments and speleothems b) Ability - He/she is able to plan and implement new projects, conduct research in a given field of science, and develop new techniques and approaches - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field. c) Attitude	

- He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable
- He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.

d) Autonomy and responsibility

- He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions
- He/she knows the limits of the adopted methods and applies them responsibly during the professional works

Professor responsible for the course: Dr. Temovski Marjan, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1052_EN Speleogenesis**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The course aims to provide an in-depth knowledge of the processes and mechanisms of karst cave formation, that are comprehensively known as speleogenesis. Understanding the basic processes of speleogenesis, allows to easier understand the concept of the evolution of the karst as a whole. As caves are both the product and the carrier of the evolution of a karst system, the knowledge of speleogenesis is important to understand the complexity of karst systems, and the connections between the surface and the underground. This has practical implications in various fields of study related to karst (landscape evolution, paleoclimate reconstructions, groundwater resources, ore minerals, archeology etc.). During the course the students will become familiar with the specifics of epigene and hypogene caves, their morphology, associated processes, sediments and their importance.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. De Waele, J., Gutierrez, F., 2022. Karst Hydrogeology, Geomorphology and Caves, First edition. John Wiley & Sons. 2. Palmer, A.N., 2007. Cave geology. Cave Books, Dayton, Ohio 3. Klimchouk, A., Palmer, A.N., De Waele, J., Auler, A.S., Audra, P. (Eds.), 2017. Hypogene karst regions and caves of the world. Cave and karst systems of the world. Springer, Cham., 911 p. 4. Audra, P., Palmer, A.N., 2013. The Vertical Dimension of Karst: Controls of Vertical Cave Pattern, in: Treatise on Geomorphology: Volume 1-14. Elsevier, pp. 186–206. https://doi.org/10.1016/B978-0-12-374739-6.00098-1 5. Temovski, M., Audra, P., Mihevc, A., Spangenberg, J., Polyak, V., McIntosh, W., Bigot, J.-Y., 2013. Hypogenic origin of Provalata Cave, Republic of Macedonia: a distinct case of successive thermal carbonic and sulfuric acid speleogenesis. Int. J. Speleol. 42, 235–246. https://doi.org/10.5038/1827-806X.42.3.7	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she has research-level knowledge of the subject area, general and specific characteristics, key trends, and precisely defined boundaries on speleogenesis, as well as its agreed and disputed connections. - He/she creatively understands the connections, theories, and conceptual systems and terminology applied in the study of cave origin b) Ability - He/she is able to creatively analyze the characteristics of speleogenesis, formulate comprehensive and specialized connections in a synthetic, novel way, and evaluate and critique them appropriately. - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field. c) Attitude - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable - He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.	

d) Autonomy and responsibility
- He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions
- He/she knows the limits of the adopted methods and applies them responsibly during the professional works

Professor responsible for the course: Dr. Temovski Marjan, assistant professor, PhD

Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE1053_EN Stable isotope geochemistry of karst systems**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The course aims to provide a stable isotope perspective of the karst systems, mainly as a tool to better understand the evolution of the karst systems, or to obtain environmental information from speleothems. During the course, the students will become familiar with the systematics of stable isotopes in karst systems, as well as their potential, and limits, in the study of various aspects of karst systems. They will get better understanding of the usage of stable isotopes in speleogenetic or speleothem-based paleoclimate research.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
- Sharp, Z., 2017. Principles of Stable Isotope Geochemistry, 2nd edition. https://doi.org/10.25844/h9q1-0p82 - Hoefs, J., 2018. Stable Isotope Geochemistry, 8th edition, Springer. - Clark, I., 2015. Groundwater Geochemistry and Isotopes, Taylor and Francis Group. - Fairchild, I.J., Baker, A., 2012. Speleothem Science: From Process to Past Environments, Wiley-Blackwell, Chichester - Temovski, M., Rinyu, L., Futó, I., Molnár, K., Túri, M., Demény, A., Otoničar, B., Dublyansky, Y., Audra, P., Polyak, V., Asmerom, Y., Palcsu, L., 2022. Combined use of conventional and clumped carbonate stable isotopes to identify hydrothermal isotopic alteration in cave walls. Sci. Rep. 12, 9202. https://doi.org/10.1038/s41598-022-12929-4	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she creatively understands the connections, theories, and conceptual systems and terminology applied in stable isotope geochemistry - He/she possesses the research methodology knowledge necessary for independent research on karst systems based on stable isotope geochemistry b) Ability - He/she is able to plan and implement new projects, conduct research in a given field of science, and develop new techniques and approaches - He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field. c) Attitude - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable - He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work. d) Autonomy and responsibility - He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions	

- He/she knows the limits of the adopted methods and applies them responsibly during the professional works

Professor responsible for the course: Dr. Temovski Marjan, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE2002_EN Mathematical statistics in geosciences**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course:	
The aim of the course is to teach PhD students quantitative, analytical thinking and enable them to understand the main principles of data collection, different levels of data for research, and understand the statistical methods associated with these levels of measurement. Based on the knowledge gained in the course, students will be able to perform their own analyses, which will help them publish their work. - Key issues in data collection (representativeness, number of elements, number of variables, and levels of data) - The effect of distribution on the reliability of studies - Hypothesis testing - Correlation - Regression analysis - Multivariate statistics	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
Compulsory: Kabacoff, R.I. 2011. R in Action. Manning Publication Co., Shelter Island Suggested: Hammer, O. 2025. PAST Reference Manual, University of Oslo, https://www.nhm.uio.no/english/research/resources/past/downloads/past5manual.pdf	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability - He/she is able to creatively develop novel, previously unknown practical applications of theoretical issues. - He/she is able to plan and implement new projects, conduct research in a given field of science, and develop new techniques and approaches. c) Attitude - He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation. - He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable. d) Autonomy and responsibility - He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession. - He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions.	

Professor responsible for the course: Dr. Szilárd Szabó, full professor, PhD, DSc
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGG5005_EN Research planning and publishing**	ECTS credit points: 2

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade:

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course:

The aim of the course is to familiarize PhD students with the basic principles of scientific publishing and to prepare them for the requirements they can expect during the four-year program. Accordingly, the curriculum is based on the following main elements:

- Requirements related to the complex exam
- Requirements for the doctoral dissertation, steps and timeline for obtaining the degree, content and formatting of the thesis, preliminary defence process, public defence process
- requirements and rules for scientific publication:
  - types of articles, types of journals, the importance of social media sites (e.g., ResearchGate, Google Scholar), Scimago Journal Rank, Norwegian list, MTMT, Tudóstér, predatory journals
  - plagiarism and self-plagiarism in journals and doctoral dissertations
  - structure and content elements of articles
  - the peer-review process from submission to acceptance

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

Kötelező:

Lövei G. 2021. Writing and Publishing Scientific Papers: A Primer for the Non-English Speaker, OpenBook Publisher, https://doi.org/10.11647/OBP.0235

Ajánlott:

Patience, G.S., Boffito, D.C., Patience, P.A. 2011. From Clutter to Clarity, íelsevier, https://researcheracademy.elsevier.com/uploads/2017-11/2014-01-15-Manuscript-preparation.pdf

Mensh B, Kording K (2017) Ten simple rules for structuring papers. PLOS Computational Biology 13(9): e1005619. https://doi.org/10.1371/journal.pcbi.1005619

Rougier NP, Droettboom M, Bourne PE (2014) Ten Simple Rules for Better Figures. PLOS Computational Biology 10(9): e1003833. https://doi.org/10.1371/journal.pcbi.1003833

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge

- He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization.

b) Ability

- He/she is able to creatively develop novel, previously unknown practical applications of theoretical issues.
- He/she is able to plan and implement new projects, conduct research in a given field of science, and develop new techniques and approaches.

c) Attitude

- He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation.
- He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable.

d) Autonomy and responsibility

- He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession. - He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions.

Professor responsible for the course: Dr. Szilárd Szabó, full professor, PhD, DSc
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGE5008_EN Cartography**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course	
The aim of the course is to provide students with basic knowledge of map editing, map types, mapping and digital map management. During the course, we will learn about the history of cartography, the cartographic techniques used over the past centuries, and modern cartographic methods.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
1. Darkes, M., Spence, M., 2017. Cartography: An Introduction. British Cartographic Society. ISBN 0904482251, 9780904482256 2. Misra, R. P., Ramesh, A., 1989. Fundamentals of Cartography. ISBN 817 0222222G. 3. Szabó 2021: Photogrammetry - a Practical Approach. University of Debrecen practice book	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) Knowledge - He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study. - knows the main possibilities of contemporary mapping systems. - He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization. b) Ability - He/she is able to interpret the processes in human frame with cartographical methods; - He/she is able to choose and transform the datatypes and datasets necessary to answer the scientific questions, is able to apply the attained methods and analyses - He/she is able to adequately evaluate the calculated results and utilize them in the investigation of spatial social processes c) Attitude - He/she is working to implement modern cartographic research results; - He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation. - He/she endeavours to integrate and broadly utilize the adopted methods during the own work d) Autonomy and responsibility - He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions - He/she knows the limits of the adopted methods and applies them responsibly during the professional works	

Professor responsible for the course: Dr. Gergely Szabó, associate professor, PhD habil,
Lecturers involved in teaching the course, if relevant:

Title and code of the course: **TPGE5012_EN Applications of Photogrammetry in Geosciences**	ECTS credit points: 2

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade:

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course

The aim of the course is to acquire basic theoretical and practical knowledge of photogrammetry. During the course, we will learn about the main components of photogrammetry, its history, and its theoretical background. The main topics of the semester: history of aerial photography, basics of photogrammetry, theory and practice of aerial photography, classical photogrammetry and its instruments,analysis of analog aerial photographs; data extraction from aerial photographs, multi-image photogrammetry – processing of small-format digital images, types of orthophotos; object photogrammetry; building photogrammetry; generation and parameterization of surface models; practical use of DEMs.

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

1. Wilfried, l., 2016: Digital Photogrammetry. ISBN 978-3-662-50462-8
2. Paul R. Wolf, Bon A. Dewitt, Benjamin E. Wilkinson, 2014: Elements of Photogrammetry with Applications in GIS. ISBN 9780071761123
3. G. Szabó 2021: Photogrammetry - a Practical Approach. University of Debrecen practice book
4. Casagrande – Sik – Szabo (ed.) 2018: Small Flying Drones - Applications for Geographic Observation. ISBN978-3-319-66576-4

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge
- He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study
- He/she knows the principles of spatial inequality calculations, relating methods and their evaluation

b) Ability
- He/she is able to creatively analyze a given field, formulate comprehensive and specialized connections in a synthetic, novel way, and evaluate and critique them appropriately.
- He/she is able to choose and transform the datatypes and datasets necessary to answer the scientific questions, is able to apply the attained methods and analyses
- He/she is able to adequately evaluate the calculated results and utilize them in the investigation of spatial social processes

c) Attitude
- He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable
- He/she represents and further develops, in relation to their own field, those relationships which, due to the specific nature of the field, contribute to the process of human self-creation.
- He/she endeavours to integrate and broadly utilize the adopted methods during the own work

d) Autonomy and responsibility
- He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions

- He/she knows the limits of the adopted methods and applies them responsibly during the professional works

Professor responsible for the course: Dr. Gergely Szabó, associate professor, PhD habil,
Lecturers involved in teaching the course, if relevant:

Title and code of the course: **TPGG5022_EN GIS Hacks – from basic to advanced applications**	ECTS credit points: **2**

Type of teaching: lecture / seminar / laboratory / consultation

Type of evaluation: exam / mid-semester grade

Semester: first / second semester

Its prerequisite(s): -

Topic of course: a concise yet informative description of the course (approx. 8-10 lines)

The course begins with an introduction to GIS fundamentals, data types, and key software. Students can learn spatial data management, georeferencing, basic spatial analysis techniques, and advanced sessions covering geoprocessing, remote sensing, and spatial modeling with a built-in modelling environment. The course culminates in a comprehensive GIS project applying multiple tools to solve real-world problems. Deliverables include georeferenced maps, spatial analyses, and detailed project reports. This course ensures students gain both foundational knowledge and advanced GIS capabilities.

Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

- Campbell, J., & Shin, M. (2012). *Geographic information system basics*. 2012 Book Archive.
- Bajjali, W. (2023). *Arcgis pro and arcgis online: Applications in water and environmental sciences*. Springer Nature.
- Crawford, D., Yaw, D., 2025. *Esri advanced guide to Python in ArcGIS*. Esri Press, Redlands, California.
- Wang, C., Mercorelli, P., Jiang, Z. (Eds.), 2026. *Remote Sensing and GIS: Innovations and Applications*. Springer, S.l.
- Mitchell, A., 2021. *Esri Guide to GIS Analysis, Volume 2: Spatial Measurements and Statistics*. ESRI, Incorporated, Place of publication not identified.

List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).

a) Knowledge

-He/she creatively understands the connections, theories, and conceptual systems and terminology that make up the given field or area of study.

- He/she possesses the research methodology knowledge necessary for independent research in a given field of science/specialization.

b) Ability

-He/she is able to creatively analyze a given field, formulate comprehensive and specialized connections in a synthetic, novel way, and evaluate and critique them appropriately.

- He/she is able to apply and further develop the specific methods of knowledge acquisition and problem solving in their field.

- He/she is able to plan and implement new projects, conduct research in a given field of science, and develop new techniques and approaches.

c) Attitude

- He/she possesses the interest and learning ability that enables the identification and solution of research problems in the field that are currently unclear and unpredictable.

- He/she is characterized by a strong professional commitment, a constant dedication to finding new paths, and an acceptance of the need for persistent work.

d) Autonomy and responsibility

- He/she creatively and independently develops and initiates new areas of knowledge and new practical solutions.

- He/she is able to participate in the formulation of theoretical and practical issues in a leading role and with a high level of cooperation.

- He/she takes responsibility for raising and answering new ethical questions related to theoretical and practical issues in their profession.

Professor responsible for the course: Boglárka BERTALAN-BALÁZS, assistant professor, PhD
Lecturers involved in teaching the course, if relevant: -

Title and code of the course: **TPGG5024 Python programming for remote sensing;**	ECTS credit points: 2
Type of teaching: lecture / seminar / laboratory / consultation	
Type of evaluation: exam / mid-semester grade:	
Semester: first / second semester	
Its prerequisite(s): -	
Topic of course: a concise yet informative description of the course (approx. 8-10 lines)	
This course introduces Python programming as a powerful tool for processing, analyzing, and visualizing remote sensing data. Participants will learn to handle geospatial datasets, perform image classification, and implement change detection using key Python libraries such as geopandas, rasterio, matplotlib, and scikit-learn. The course bridges theoretical understanding and practical skills through hands-on exercises and project-based learning. Emphasis is placed on developing efficient data workflows, integrating multisource remote sensing data, and applying both classical and machine learning approaches. By the end of the course, students will be able to design and execute automated analysis pipelines and explore advanced techniques in deep learning for Earth observation applications.	
Literature – Please list the 2-5 most important *mandatory* and *recommended* readings (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
Jensen, J. R. (2015). Introductory digital image processing: A remote sensing perspective (4th ed.). Pearson Education. ISBN-13: 978-0134058160 Géron, A. (2022). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems (3rd ed.). O'Reilly Media. ISBN-13: 978-1098125974	
List of the required professional competencies and competency elements that the course typically contributes to in a substantive way (MKKR level 8).	
a) knowledge - Has research-level understanding of Python-based remote sensing analysis, including current trends in automation, data fusion, and AI applications. - Understands theoretical and methodological foundations connecting remote sensing concepts with computational and data science approaches. - Possesses the research knowledge required for independent work, including model design, validation, and geospatial data integration. b) ability - Can analyze and solve remote sensing problems using Python tools such as rasterio, geopandas, and scikit-learn. - Can design and implement automated workflows for image processing, classification, and change detection. - Can plan and carry out research independently, developing innovative methods and solutions for geospatial data analysis. c) attitude - Can analyze and solve remote sensing problems using Python tools such as rasterio, geopandas, and scikit-learn. - Can design and implement automated workflows for image processing, classification, and change detection. - Can plan and carry out research independently, developing innovative methods and solutions for geospatial data analysis d) autonomy and responsibility - Works independently to create new analytical methods and contribute to emerging research areas.	

- Takes a leading role in planning, executing, and communicating theoretical and applied projects. - Acts responsibly and ethically in research, engaging as an equal partner with experts from related fields.

Professor responsible for the course: Dr. Dávid Abriha, assistant professor, PhD
Lecturers involved in teaching the course, if relevant (*name, position, academic degree*):