Radioisotope detection techniques and their application in environmental geochemistry

- COURSE SYLLABUS

1.	**Course title:**	
	Radioisotope detection techniques and their application in environmental geochemistry	
2.	**Lecturers:**	
	Dr Ilona Sekudewicz – course leader (ING PAN), prof.dr hab Jerzy Mietelski (IFJ PAN) and prof. dr Agata Zaborska (IO PAN)	
3.	**Field, type and level of studies, year of study:**	
	geology, radiochemistry, geochemistry – full-time doctoral studies, all years	
4.	**Course character:**	
	compulsory lectures, seminars and discussions	
5.	**Teaching method:**	
	ONLINE *(interactive contact with lecturers in real time)*	
6.	**Language:**	*English, Polish depending on the audience and the lecturer*
7.	**Course type and number of hours:**	
	Lecture with seminar elements (30h)	
8.	**Estimated load of student's independent work:**	**10 h**
9.	**Total workload and number of ECTS points:**	**2 ECTS**
10.	**Short description and main focus of the course:**	
	This course focuses the application of radionuclides as powerful tools in geosciences, emphasizing their role in tracing environmental processes, dating sediment records, and understanding Earth's systems. Students will examine the behavior, distribution, and transport of radionuclides in various environmental matrices such as soil, sediment, and water. The course integrates theoretical knowledge with practical case studies, highlighting how radionuclides contribute to geochronology, hydrology, paleoclimatology, and environmental forensics. An important part will be sample preparation and measurement methods for detecting radionuclides. The course will further introduce main applications of radionuclides in geosciences, especially in environmental geochemistry. Most knowledge will be shared by experienced researchers in presented study area. *Our lectures and seminars will include these subjects:*	

	i. *Introduction: overview of radioactivity (I. Sekudewicz)* ii. *Geochemical behavior of selected radionuclides (I. Sekudewicz)* iii. *Application of radionuclides in environmental geochemistry (I. Sekudewicz)* iv. *Invited lecture: application of radionuclides in selected examples (J. Mietelski)* v. *Invited lecture: application of radionuclides in selected examples (A. Zaborska)* vi. *Sample collection and processing techniques (I. Sekudewicz)* vii. *Radiometric methods: Alpha and gamma spectrometry (I. Sekudewicz)* viii. *Mass spectrometry: Principles and Applications; part 1 (I. Sekudewicz)* ix. *Mass spectrometry: Principles and Applications; part 2 (I. Sekudewicz)* x. *Seminar and summary of the course (I. Sekudewicz)* *Lectures will be supplemented by interactive seminars with contributions of all participating students.*	
11.	**References:** • *Appleby, P.G., 2008. Three decades of dating recent sediments by fallout radionuclides: A review. Holocene 18, 83–93. https://doi.org/10.1177/0959683607085598* • *Dickin, A.P., 2005. Radiogenic Isotope Geology. Cambridge University Press.* • *Hou, X., Roos, P., 2008. Critical comparison of radiometric and mass spectrometric methods for the determination of radionuclides in environmental, biological and nuclear waste samples. Anal. Chim. Acta 608, 105–139. https://doi.org/10.1016/J.ACA.2007.12.012* • *IAEA, 2011. Radioactive Particles in the Environment: Sources, Particle Characterization and Analytical Techniques - TECDOC No. 1663, IAEA, Vienna.* • *IAEA, 2013. Isotopes in Hydrology, Marine Ecosystems and Climate Change Studies, Proceedings Series, IAEA, Vienna.* • *Inorganic Ventures Website: https://www.inorganicventures.com/education* • *Mitra, S., 2003. Sample Preparation Techniques in Analytical Chemistry. John Wiley and Sons Inc., Hoboken.* • *Smith, J., Nicholas A., 2005. Beresford. Chernobyl — Catastrophe and Consequences. Springer.* • *Swarzenski, P.W., 2014. ^{210}Pb Dating, in: Encyclopedia of Scientific Dating Methods. Springer Netherlands, Dordrecht.* • *Thomas, R., 2013. Practical Guide to ICP-MS: A Tutorial for Beginners, Third Edition (3rd ed.). CRC Press.* • *Zapata, F., Nguyen, M.L., 2009. Chapter 7. Soil Erosion and Sedimentation Studies Using Environmental Radionuclides, Radioactivity in the Environment. Elsevier.*	
12.	**Prerequisites:** *Knowledge of radiochemistry, sedimentology, environmental geochemistry, radioecology*	
13.	**Educational outcomes:**	**PQF level 8 codes:**
	Knowledge: *The student has basic knowledge of selected radionuclides and their application in environmental geochemistry; knows methods used to detect selected radionuclides;*	***P8S_WG***
	Practical Skills: *This course provides a comprehensive introduction to the fundamental principles of radiochemistry, emphasizing advanced measurement techniques, such as alpha and gamma spectrometry and mass spectrometry (ICP-MS). Students will develop proficiency in the methodologies for preparing various sample types, tailored to the specific*	***P8S_UW, P8S_UU***

	requirements of the chosen radiometric techniques. The course also investigates the behavior and significance of radionuclides in geosciences, especially in environmental geochemistry.	
	Social Skills: *The student is able to evaluate the presented material critically, ask questions, and recognize the importance of choosing appropriate methods for collecting and processing samples. They can apply the acquired knowledge in planning future research activities and choosing appropriate measurement methods.*	***P8S_KK***
14.	**Evaluation of the educational outcomes:** *Presentation, student's commitment during the classes, discussions during lecture and seminars*	
15.	**Criteria to complete the course:** *Minimum 80% of attendance, final grade depends on the presentation and the student's commitment during the classes*	
16.	**Contact with the course leader/lecturer:** *i.sekudewicz@twarda.pan.pl (no major time restrictions), meetings on Zoom or ING PAN in Warsaw (Institute of Geological Sciences, Polish Academy of Sciences, Research Center in Warsaw, Twarda 51/55, 00-818 Warsaw) are possible upon earlier agreements*	