Podiplomskašola ZRCSAZU
Novi trg 2
1000 Ljubljana
T: +386 1 470 64 51

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Napredne študije podpovršja Zemlje
Course title:	Advanced Studies of the Earth's Subsurface

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Okoljske in regionalne študije, doktorski študij 3. stopnje	4D Zemlja	/	/
Environmental and Regional Studies, doctoral study 3rd cycle	4D Earth	/	/

Vrsta predmeta / Course type: Izbirni / Elective

Univerzitetna koda predmeta / University course code: DIZ04

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija – Teren/ Field work	Samost. delo Individ. work	ECTS
20	30			20	110	6

Nosilec predmeta / Lecturer: doc. dr. Marjana Zajc
(ostali izvajalci: dr. Matevž Novak, dr. Jure Atanackov, dr. David Gerčar)

Jeziki / Languages:

Predavanja / Lectures:	Slovenščina, angleščina/Slovene, English
Vaje / Tutorial:	Slovenščina, angleščina/Slovene, English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Končana druga bolonjska stopnja ustrezne smeri ali univerzitetni študij VII stopnje

Prerequisits:

Second-cycle Bologna degree in the relevant track or a university (level VII) degree.

Vsebina:

- geološka karta, izdelava geološke karte in njena interpretacija s poudarkom na geoloških kartah in geoloških profilih širšega območja raziskav doktorske disertacije študenta oz. študentke;
- postavitev hidrostratigrafskih in tektonskih konceptov raziskovanega območja;
- tipi vhodnih podatkov za geološko 3D modeliranje podpovršja z možnostmi, ki so na voljo na območju raziskav doktorske disertacije študenta oz. študentke;

Content (Syllabus outline):

- geological map, creating a geological map and its interpretation with an emphasis on geological maps and geological profiles of the wider research area of the student's doctoral dissertation;
- establishment of hydrostratigraphic and tectonic concepts within the specific research area;
- types of input data for geological 3D modeling of the subsurface with options available in the research area of the student's doctoral dissertation;

• principi pridobivanja podatkov o geološki in strukturni sestavi podpovršja s karotažo ter geofizikalnimi metodami; • delovanje in uporaba različnih geofizikalnih metod, njihove prednosti in omejitve (georadar, ERT, refleksijska in refrakcijska seizmika) ter njihova uporaba na izbranem območju znotraj doktorske disertacije; • terensko delo: meritve z izbrano metodologijo, ki je smotrna za raziskave znotraj doktorske disertacije študenta oz. študentke; • večmetodni pristop k uporabi geofizikalnih metod; • procesiranje in interpretiranje pridobljenih geofizikalnih podatkov ter njihov prostorski prikaz.	• principles of obtaining data on the geological and structural setting of the subsurface using well-logging and geophysical methods; • the operation and use of various geophysical methods, their advantages and limitations (geographic radar, ERT, reflection and refraction seismic) and their use in the selected area within the doctoral dissertation; • fieldwork: measurements with a selected methodology, suitable for research within the student's doctoral dissertation; • multimethod approach to the use of geophysical methods; • processing and interpretation of acquired geophysical data and their spatial display.

Temeljni literatura in viri / Readings:

- Jol, H. M. (2009). Ground Penetrating Radar: Theory and Applications. Amsterdam, Netherlands, Oxford, UK: Elsevier Science, 524 str.
- Kirsch, R. (2009). Groundwater geophysics: a tool for hydrogeology (2nd ed., str. XV, 548). Springer.
- Novak, M. (2023). Iz zgodovine geoloških kart slovenskega ozemlja: Osnovna geološka karta Slovenije. Zbornik za zgodovino naravoslovja in tehnike. Zv. 17, str. 111-126. ISSN 0351-4250. [COBISS.SI-ID 173622275]
- Novak, M., Jamšek Rupnik, P., Atanackov, J., Mali, N. (2014) Izdelava metodologije in pilotnega vnosa hidrogeološke karte M 1: 25.000. Zvezek 2.2, Metodologija izdelave hidrogeološke karte - geološke vsebine. Ljubljana: Geološki zavod Slovenije, 2014. 23 str. [COBISS.SI-ID 2358101]
- Placer, L. (2008). Principles of the tectonic subdivision of Slovenia: Osnove tektonske razčlenitve Slovenije. Geologija 51, 2: 205-217.
- Turner, A.K., Kessler, H., van der Meulen, M. K. 2021. Applied Multidimensional Geological Modeling: Informing sustainable human interactions with the shallow subsurface (str. XXVIII, 644). John Wiley & Sons.
- Utsi, E. C. (2017). Ground penetrating radar: theory and practice (str. XVII, 205). Butterworth-Heinemann, an imprint of Elsevier.
- Wellmann, F., Caumon, G. (2018). 3-D Structural geological models: Concepts, methods, and uncertainties. Cedric Schmelzbach. Advances in Geophysics, 59, Elsevier, str. 1-121. (dostop: https://hal.univ-lorraine.fr/hal-01921494/file/structural_models_for_geophysicsHAL.pdf)
- Zhou, H.-W. (2014). Practical Seismic Data Analysis. Cambridge University Press. ISBN 978-0-521-19910-0.

Cilji in kompetence:	Objectives and competences:
Namen predmeta je osvojiti globlje, napredno znanje o geološkem kartiranju, izdelovanju in branju geoloških kart, 3D geološkem	The purpose of the course is to gain deeper, advanced knowledge of geological mapping, creating and reading geological maps, 3D

modeliranju ter pridobivanju podatkov o podpovršju Zemlje z geofizikalnimi metodami. Vsebina je prilagojena tematiki doktorske disertacije študenta oz. študentke. Ta zna opravljati z izbrano geofizikalno opremo na terenu, pridobljene podatke obdelati, primerno integrirati z obstoječimi podatki ter rezultate prostorsko prikazati.	geological modeling and obtaining data about the Earth's subsurface using geophysical methods. The content is adapted to the topic of the student's doctoral dissertation. The PhD student knows how to work with the selected geophysical equipment in the field, process the obtained data, appropriately integrate them with existing data and spatially display the results.

Predvideni študijski rezultati:	Intended learning outcomes:
• Razumevanje geoloških kart in njihovega pomena; • poznavanje glavnih principov geološkega 3D modeliranja in tipov vhodnih podatkov; • znanje o različnih geofizikalnih metodah; • apliciranje pridobljenega znanja pri izbiri primernih metod za raziskave znotraj doktorske disertacije; • opravljanje z geofizikalno opremo na terenu, obdelava podatkov ter njihova interpretacija; • priprava 3D modela raziskovanega območja.	• Understanding of geological maps and their meaning; • Knowledge of the main principles of geological 3D modeling and types of input data; • knowledge of various geophysical methods; • application of acquired knowledge in choosing suitable research methods within the doctoral dissertation topic; • working with geophysical equipment in the field, data processing and data interpretation; • construction of a 3D model of the research area.

Metode poučevanja in učenja:	Learning and teaching methods:
☒Predavanja	☒Lectures
☒Terensko delo	☒ Field work
☒Seminar	☒Seminar
☒Individualne naloge	☒Independent work assignments
☒Konzultacije	☒Consultations
☒e-izobraževanje	☒e-Learning

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminarska naloga z zagovorom	100	Written seminar paper and defence

Reference nosilca / Lecturer's references:

- **ATANACKOV, Jure**, GOSAR, Andrej. Field comparison of seismic sources for high resolution shallow seismic reflection profiling on the Ljubljana Moor (central Slovenia). *Acta geodynamica et geomaterialia*. 2013, vol. 10, no. 1 (169), str. 19-40. ISSN 1214-9705. [COBISS.SI-ID 2136661]
- **GERČAR, David**, ZUPANČIČ, Nina, WAŚKOWSKA, Anna, PAVŠIČ, Jernej, ROŽIČ, Boštjan. Upper Campanian bentonite layers in the Scaglia-type limestone of the northern Dinarides (SE Slovenia). Cretaceous research. [Print ed.]. 2022, vol. 134, str. 1-20. ISSN 0195-6671. Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1016/j.cretres.2022.105158. [COBISS.SI-ID 97302531]
- JAMŠEK RUPNIK, Petra, **ATANACKOV, Jure**, HORN, Barbara, MUŠIČ, Branko, **ZAJC, Marjana**, GRÜTZNER, Christoph, USTASZEWSKI, Kamil, TSUKAMOTO, Sumiko, **NOVAK, Matevž**, MILANIČ,

Blaž, MARKELJ, Anže, IVANČIČ, Kristina, NOVAK, Ana, JEŽ, Jernej, ŽEBRE, Manja, BAVEC, Miloš, VRABEC, Marko. Revealing subtle active tectonic deformation: integrating lidar, photogrammetry, field mapping, and geophysical surveys to assess the Late Quaternary activity of the Sava Fault (Southern Alps, Slovenia). *Remote sensing*. 2024, vol. 16, no. 9, 33 str. ISSN 2072-4292. DiRROS - Digitalni repozitorij raziskovalnih organizacij Slovenije, DOI: 10.3390/rs16091490.

- **NOVAK, Matevž**, FORKE, Holger C., SCHÖNLAUB, Hans Peter. The Pennsylvanian-Permian of the Southern Alps (Carnic Alps/Karavanke Mts.), Austria/Italy/Slovenia - fauna, facies and stratigraphy of a mixed carbonate-siliciclastic shallow marine platform along the northwestern Palaeotethys margin : Field Trip C3. V: HERBIG, Hans-Georg (ur.) et al., 19th International Congress on the Carboniferous and Permian, Cologne, July 29-August 2, 2019 : field guides. Köln: Inst. F!ur Geologie und Mineralogie, Univ. Köln, str. 251-302. ISSN 1437-3246.
- **ZAJC, Marjana**, CELARC, Bogomir, GOSAR, Andrej. Structural-geological and karst feature investigations of the limestone-flysch thrust-fault contact using low-frequency ground penetrating radar (Adria-Dinarides thrust zone, SW Slovenia). Environmental earth sciences. 2015, vol. 73, no. 12, str. 8237-8249. ISSN 1866-6280. http://dx.doi.org/10.1007/s12665-014-3987-x, DOI: 10.1007/s12665-014-3987-x.
- **ZAJC, Marjana**, POGAČNIK, Željko, GOSAR, Andrej. Ground penetrating radar and structural geological mapping investigation of karst and tectonic features in flyschoid rocks as geological hazard for exploitation. International journal of rock mechanics and mining sciences. April 2014, vol. 67, str. 78-87. ISSN 1365-1609. http://dx.doi.org/10.1016/j.ijrmms.2014.01.011