Course guides
250825 - 250825 - Environmental Isotope Techniques in Groundwater Hydrology

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Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2020 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: DANIEL FERNANDEZ GARCIA

Others: MARCOS CARNICERO DEL RIO, DANIEL FERNANDEZ GARCIA, ALBERT FOLCH SANCHO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13308. To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
13310. To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose laboratory testing programmes.
13315. To calculate, evaluate, plan and regulate surface and groundwater resources.(Specific competence of the specialization in Groundwater Hydrology).
13316. To assess and manage environmental impacts from waste disposal, soil contamination and groundwater pollution. (Specific competence of the specialization in Groundwater Hydrology).
13323. To model, assess and manage geological resources, including mineral and thermal groundwater. (Specific competence of the specialization in Groundwater Hydrology).

Generical:
13300. To apply advanced knowledge in sciences and technology to the profesional or research practice.
13301. To lead, coordinate and develop integrated projects in Geo-Engineering.
13302. To identify and design solutions for geo-engineering problems within ethical, social and legislative frameworks.
13303. To evaluate the impact of Geo-engineering on environment, sustainable social development and the significance of working within reliable and consciensous profesional environment.
13304. To incorporate new techncologies and advanced tools in Geo-engineering into profesional and research activities.
13305. To conceive Geo-engineering as a multi-disciplinary field that includes relevant aspects from geology, sismology, hydrogeology, geotechnical and earthquake engineering, geomechanics, physics of porous media, geophysics, geomatics, natural hazard, energy and climate interactions.
13306. To promote innovation for the development of methodology, analyses and solutions in Geo-engineering
13307. To tackle and solve advanced mathematical problems in engineering from the drafting of the problem to the development of formulation and further implementation in computer programs. Particularly, to formulate, code and apply analytical and numerical advanced computational tools to project calculations in order to plan and manage them as well as to interpret results in the context of Geo-engineering and Mining engineering.

TEACHING METHODOLOGY

The course consists of 2 hours per week of classroom activity (large size group) and 1 hour weekly with half the students (medium size group).

The 2 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 1 hour in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

LEARNING OBJECTIVES OF THE SUBJECT

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose laboratory testing programmes.
To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.
To analyze, discriminate and integrate geological and geotechnical information in studies and projects.
To calculate, evaluate, plan and regulate surface and groundwater resources.(Specific competence of the specialization in Groundwater Hydrology).
To assess and manage environmental impacts from waste disposal, soil contamination and groundwater pollution. (Specific competence of the specialization in Groundwater Hydrology).
To model, assess and manage geological resources, including mineral and thermal groundwater. (Specific competence of the specialization in Groundwater Hydrology).

* To know the existence of isotopes and basic isotopic techniques for hydrogeological studies.
* To distinguish stable isotopes from radioactive isotopes and the different applications derived from them.
* To Know and use the modern water dating techniques based on isotopic techniques.
* To know and use the isotopic techniques to assess the contamination and decontamination of soils and aquifers.
* To model the chemical balance and kinetic processes from the multidisciplinary point of view, incorporating thermo-hydro-geochemical concepts.
* To plan and solve in complicated cases the reactive transport equations.
* To model transport problem data in laboratory or on field.
* The basic challenges of subsoil heterogeneity and implications on predicting the transport in heterogeneous media are introduced.
* To analyze the stochastic approaches with regards to the quantification of heterogeneity-induced transport phenomena.
* To acquire the basic tools for stochastic modelling.
* To expose the modern approaches to modelling transport in heterogeneous media.

- Stable isotopes. Equilibrium and kinetic partitioning.
- Water isotopy in atmospheric and fluvial environments.
- Radioactive isotopes . Principles. Radioisotopes of interest. Water dating.
- Isotopic and isotopic groundwater models.
- Water isotopy in high temperature systems. Low and medium enthalpy geothermy.
- Stable isotopes of carbon and radiocarbon (14C). Open systems and closed systems. 13C -14C relationships.
- Isotopy of sulfur and sulfate oxygen.
- Isotopic variations of nitrogen and chlorine. Variations in nature and groundwater.
- Isotopes of heavy elements. U and Th series.
- Tracing and dating with noble gases and their isotopes.

STUDY LOAD

Type	Hours	Percentage
Laboratory classes	9,8	7.83
Self study	80,0	63.95
Practical classes	9,8	7.83
Theory classes	19,5	15.59
Guided activities	6,0	4.80

Total learning time: 125.1 h

CONTENTS

Topic 1

Description:
Basic Principles on stable isotopes. Equilibrium and kinetic fractionation. Rayleigh processes

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Theme 2

Description:
As of stable isotopes. Mass spectrometers. Water isotopes. Corrections salinity. TAMS. Reference standards of

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Topic 3

Description:
Isotopy of water in the atmosphere. Precipitation. Continental precipitation. Effects of continental, altitude, latitude. Deuterium excess

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Topic 4

Description:
Steam generated over the ocean and ocean water. River water. Free evaporation effects. Evaporating reservoirs. Balance lakes. d18O air. d17O

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Item 5

Description:
Steam generated over the ocean and ocean water. River water. Free evaporation effects. Evaporating reservoirs. Balance lakes. d18O air. d17O

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Topic 6

Description:
Isotopy of groundwater. Origin of recharge. Brand altitude. Brand evaporation. Mixtures of groundwater. Supply of seawater. Interaction with the ground. Various examples

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Topic 7

Description:
Isotopic models for groundwater. Aggregates models parameters. Mixing-cell models and numerical. Application tritium. Old concept. Applications

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Topic 8

Description:
Isotopy water in elevated temperature systems. Geothermal medium and low enthalpy

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Topic 9

Description:
Isotopic fractionation of water evaporation from the middle unsaturated. Examples

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Item 10

Description:
Tritium in the terrain profile. Interpretation. Paleoaguas. Examples

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Item 11

Description:
Stable isotopes of carbon. Standards. Measure. Variations in the nature and groundwater, depending on the chemistry of dissolved inorganic carbon in the water. Modifiers phenomena. Interpretation of results

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Item 12

Description:
Radiocarbon (14C). Units. Measure. Variations in the nature and anthropogenic effects. 14C in groundwater

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Item 13

Description:
Interpretation of 14C in groundwater. Open systems and closed systems. Hydrogeochemical and isotopic models. 13C-14C

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Item 14

Description:
Applications radiocarbon dating to groundwater. Deltaic areas and reducing zones. Volcanic aquifers

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Item 15

Description:
Isotopy of sulfur and sulfate oxygen. Standards and measurement. Variations in nature. Interpretation into groundwater

Full-or-part-time: 3h 35m
Theory classes: 1h 30m
Self study : 2h 05m

Topic 16

Description:
Isotopic variations of nitrogen and chlorine. Variations in the nature and groundwater. 36Cl. Origin and variations. Interpretation into groundwater

Full-or-part-time: 4h 33m
Theory classes: 1h 54m
Self study : 2h 39m

Topic 17

Description:
Isotopes of heavy elements. And U and Th series. Causes of isotopic variations. Imbalances. Ratio 234U / 238U in groundwater. Other Applications

Full-or-part-time: 4h 33m
Theory classes: 1h 54m
Self study : 2h 39m

practices

Description:
It is not expected that scheduled visits except isotope laboratories (one or two) practices are made.

Full-or-part-time: 30h 28m
Laboratory classes: 12h 42m
Self study : 17h 46m

GRADING SYSTEM

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

EXAMINATION RULES.

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

BIBLIOGRAPHY

Basic:

- Clark, I.D.; Fritz, P. Environmental isotopes in hydrogeology. Boca Raton, FL: CRC Press, 1997. ISBN 9781566702492.
- Cook, P.; Herczeg, A. Environmental tracers in subsurface hydrology. Boston: Kluwer, 2000. ISBN 9780792377078.
- Mazor, E. Chemical and isotopic groundwater hydrology. 3rd ed. New York: Basel : M. Dekker, 2004. ISBN 9780824747046.
- Mook, W.G.. Isótopos ambientales en el ciclo hidrológico: principios y aplicaciones. Madrid: Instituto Geológico y Minero de España, 2002. ISBN 8478404651.
- Nagoya, K. Hydrogen and oxygen isotopes in hydrology [on line]. Paris: UNESCO, 2001 [Consultation: 13/05/2021]. Available on: http://www.hyarc.nagoya-u.ac.jp/japanese/02activity/ihp/11ihptc.html.
- Custodio, E.; Llamas, M.R. (eds.). Hidrología subterránea. 2a edición corregida. Barcelona: Omega, 1983. ISBN 8428204462.
- Fritz, P.; Fontes, J.Ch. Handbook of environmental isotope geochemistry, vol.3. Elsevier, 1989. ISBN 0444427643.