Alternative course guide

Earth Life and Climate

Last updated: 07-11-2014

Onderwijscommissie der U.A.V.

Introduction

This is the course guide made by students of the committee for education of the U.A.V. It serves as an alternative for the official course guide. Here you can read the positive and negative experiences of students, stories of students that tell which course fitted in their track and which didn't, and all important points from the evaluations, for example the work load. The alternative course guide is updated every period by the committee for education of the U.A.V. It is not complete yet, but we hope you nevertheless can use it to make better choices for your master's program.

In this guide the four tracks of Earth Life and Climate can be found. For each track, at first a student that followed that track tells about his or her choices for courses and his or her experiences. Then the individual courses are discussed. Also the M-Profiles *GEO-Resources* and *Earth and Sustainability* are discussed.

The different tracks and different programs are partly overlapping. This means that one course can be part of more than one program. The students which evaluated the courses are part of only one track and therefore their experience might be slightly different than that of a student following the same course in a different track. Did you read something which is incomplete? Do not hesitate to contact us!

Tutor of Earth Life and Climate: Lucas Lourens (l.j.lourens@uu.nl).

Contents

1. Integrated stratigraphy and sedimentary systems

For each track you have to choose at least 5 track courses, of which at least 3 from the top box.

Track: Integrated stratigraphy and sedimentary systems
Astronomical climate forcing and time scales Dynamics of sedimentary systems Paleomagnetism Fluvial systems
Dynamics of basins and orogens Reconstructing Quaternary environments Paleoceanography and climate variability Field research instruction geology **or** excursion Physical Geography

1.1 Astronomical climate forcing and time scales

Overview

Period	2	Course code	GEO4-1412
Timeslot	B	Mean rating last year	7.7
Teacher	Frits Hilgen	Mean workload last year	~18 h
Contact	f.j.hilgen@uu.nl	Success rate last year	

Acquired knowledge and skills

Knowledge: This course gives you more understanding of climate variability and in particular how astronomical cycles influence climate. You gain advanced knowledge about the Milankovitch cycles and how they influence climate.

Skills: Improved Excel skills during the computer practicals. You also make your own geological time-scale during one of the practicals. Another skill you gain in this course is to recognize astronomical cycles in a sedimentary record.

Assessment, structure and work load

The course is structured by lectures and computer practicals. Furthermore the course has a midterm test (20% of the final grade) and a final test (45% of the final grade). The remaining 35% of the grade is equally divided over an essay and oral presentation. The work load is evenly spread throughout the period.

Experiences

The course was good organized and very useful for future sedimentologists. I learned a lot during this course and acquired new skills. I really understand the mechanism of astronomical cycles influencing climate a lot better. Frits Hilgen is also a very dedicated teacher with interactive lectures and supplying summaries of the lectures for the exam.

1.2 Dynamics of sedimentary systems

Overview

Period	3	Course code	GEO4-1419

Timeslot	D	Mean rating last year	4.8
Teacher	dr. J.T. Eggenhuisen	Mean workload last year	16-20h
Contact	j.t.eggenhuisen@uu.nl	Success rate last year	93.5%

Acquired knowledge and skills

The main thing learned in this course is relating different types of models to one another. This includes numerical models, physical models and conceptual models. The knowledge acquired about modelling and how to value and relate different models could be also very useful in other fields of (earth) science. This is of course done in the setting of sedimentary systems, of which a lot is learned mainly by reading and discussing high-quality papers.

Assessment and work-load

The course is constructed of lectures, numerical modelling labs and physical modelling in the Eurotank, of which reports are expected to be handed in. There also is a team-project in which a research proposal is written and presented. The work-load is moderate to high in comparison to other courses. Due to the team project at the end of the course the main weight of the work is experienced during the last few weeks.

Experiences

Both Joris and Paul are very pleasant lecturers to listen to and explain things very clearly. During Joris' lectures the focus will be on physical modelling of sedimentary systems, and the general concepts behind sedimentology and sedimentary geology. During Paul's lectures the focus will be on the mathematical description of sedimentary processes and basic numerical modelling will be applied during the computer labs. Due to a relatively small group of students (20-25 in '12-'13), the lecturers are very approachable. During the course there also is a three-day field trip to northern France in which the concepts learned in class can be seen in the field, the trip is a lot of fun! *In 2013-2014 this fieldtrip was cancelled because the lecturers did not have time.*

1.3 Paleomagnetism

Overview

Period	3	Course code	GEO4-1438
Timeslot	A	Mean rating last year	7.4
Teacher	M.J. Dekkers; W. Krijgsman; C.G. Langereis	Mean workload last year	
Contact	W.Krijgsman@uu.nl	Success rate last year	

Acquired knowledge and skills

Knowledge: first encounter with rock magnetism and their applications: magnetostratigraphy, rotational studies and paleointensity studies

Skills: interpretation of rock magnetic measurements and paleomagnetic data, writing a proposal for scientific funding in NWO format

The Osiris description is very clear. The course is not specific for one track, since the topic is related to many study areas. To a large extent you are allowed to choose topics that interest you.

Assessment, structure and work load

The course contains lectures and many exercises; computer exercises and tutorials with interactive presentations (30%), one large 'hands-on' study (20 %) and writing and presenting a scientific proposal (40 %). Class participation is also graded (10%). There is no final exam. All computer practicals are performed in teams of two. The work load is constantly high with a peak in the final weeks *(the lecturers promised to improve this in the evaluation of 2012-2014)*.

Experiences
The team of lecturers is very enthusiastic and a lot of assistance is present during practical sessions. We always received feedback on assignments, and were allowed to hand-in improved versions for a higher grade. Moreover, writing a research proposal was very instructive. Some students noted in the evaluation that they would have liked more scheduled sessions with assistance.

1.4 Fluvial systems

Overview

Period	1	Course code	GEO4-4436
Timeslot	A	Mean rating last year	
Teacher	Dr. M.G. Kleinhans	Mean workload last year	18 hours
Contact		Success rate last year	>75%

N.B. for the track coastal dynamics and fluvial systems this course is highly recommended due to the importance of the subject, it is considered to be one of the core courses for this track. This is, however, not a limitation for other students to follow this course.

Acquired knowledge and skills
Knowledge: In the course Fluvial systems, I gained knowledge and insight about fluvial processes (e.g. sediment transport, avulsion) and associated (Quaternary) deposits.
Skills: modeling in MATLAB

Assessment, structure and work load
The course consists of lectures and practicals. The work load of this course is really high and can feel like a burden at times, but this guarantees that you learn a lot.

Experiences
In the course Fluvial systems, I gained knowledge and insight about fluvial processes (e.g. sediment transport, avulsion) and associated (Quaternary) deposits. The main skill that I acquired is modeling in MATLAB, which was done during most of the practicals. The manual for these exercises is very well done, which made the introduction to modeling a positive experience. Lectures given by different teachers provided a nice amount of variety. Overall, I think Fluvial systems was a good contribution to my track (Integrated Stratigraphy and Sedimentary Systems), because it is really useful to be familiar with the process-oriented way of thinking that was taught.

1.5 Dynamics of basins and orogens

Overview

Period	2	Course code	GEO4-1418
Timeslot		Mean rating last year	7.6
Teacher	P.T. Meijer; L.C. Matenco	Mean workload last year	
Contact		Success rate last year	29 out of 31

Acquired knowledge and skills
Knowledge: mechanics (eg. isostasy) (Meijer) & interplay of lithosphere, crustal structures and sedimentation in basins and orogens (Matenco)
Skills: presenting a scientific article in a structured way, first order recognition of syn- & post-rift sedimentation in seismic sections, basic physical modeling of isostatic processes

The Osiris description is short but adequate; however from 2012-2013 I did no remember anything about 'economic-relevant reserves'. The course is not part of the Earth Materials track, but I found it very useful for my general geology knowledge. If you really like physics, it is advised to take the Tectonophysics course instead of this one.

Assessment, structure and work load
Weekly lectures and practicals (computer and classroom), and presentation sessions. The practicals, presentation, class participation (10%) and final exam are assessed (%)? The workload in 2012-2013 was balanced and relatively low, but in 2013-2014 a final exam was introduced, therefore the work load must have increased.

Experiences
The two lecturers are very different in background and approach, which resulted in a course with a pleasant variety in between physics and case studies. I learned many completely new things. The presentations were well-guided and led to scientific discussions. Sometimes I was overloaded with information, but the lecturers are always available for questions.

1.6 Reconstructing quaternary environments

Overview

Period	2	Course code	GEO4-4409
Timeslot	C	Mean rating last year	7,4
Teacher	Wim Hoek	Mean workload last year	~10 h
Contact	w.hoek@geo.uu.nl	Success rate last year	18 out of 18

Acquired knowledge and skills
Knowledge: Understanding how the Quaternary climate and environment changed and how you can reconstruct the environment. Thus understanding different kind of proxies and dating techniques.
Skills: Using different kind of proxies and techniques to reconstruct the Quaternary environment and climate. Amongst others using pollen to recognize species and reconstruct the environment.

Assessment, structure and work load
There course consists of lectures and practicals every week.
The exam at the end counts for 70% of the final grade. The remaining 30% of the grade is composed of a written paper (15%) and presentation (15%). The workload of the course is not very heavy.

Experiences
This course is actually a combination between biogeology and physical geography. The focus is on climatic and environmental change, which is part of biogeology. But the timeframe is the Quaternary and the method is to use characters of physical geography to identify the change. For example, there is a lot of attention to pingo's. So although the level of this course was not very challenging, it broadens the knowledge. For the track of climate reconstruction it is useful to also have knowledge of this physical geography part for identifying climate change. These are features which you can usually identify easy in the landscape but are not covered in other courses, because it is only suitable for a relatively short timescale. I liked to have a more physical geography course and focus on other features. For example the practical about using pollen proxies I found nice.
We also had an excursion to TNO; some guest lectures and a practical in dendrology at an institute in Amersfoort. This was very nice and good organized.

1.7 Paleoceanography and climate variability

Overview

Period	1	Course code	GEO4-1405
Timeslot	B	Mean rating last year	7.4
Teacher	Gert Jan Reichart	Mean workload last year	~16 h
Contact	g.j.reichart@uu.nl	Success rate last year	16 out of 22

Acquired knowledge and skills
Knowledge: Understanding the (paleo)ocean circulation during different climatic regimes, and the related proxy variability. The bachelor course paleoceanography focused more on the basics of understanding the ocean system. About how the physical and the chemical components of the ocean work. This master course is more applied to different climatic regimes.
Skills: improved Excel skills (computer practical).

Assessment, structure and work load
Two days in the week you have two hours of lectures, followed by a two hour computer practical about the lecture subject. You have to hand in these practicals every week, which will be graded. There is a final exam which count for 70% of your grade. Because you have to hand in the practical every week, the workload is quite evenly distributed.

Experiences
The course is well organized. Lucas Lourens and Martin Ziegler also gave some lectures. The structure of lectures followed by computer practicals about the same topic works really good. There was also enough guidance during the practicals and you received every week feedback on your previous assignment.

1.8 Field research instruction geology (Spain)

Overview

Period	4	Course code	GEO4-1430
Timeslot	Second half	Mean rating last year	8.2
Teacher	J.H.P de Bresser F.J. Hilgen Liviu Matenco	Mean workload last year	
Contact		Success rate last year	33 out of 33

Acquired knowledge and skills
For this field course, the amount and type of acquired knowledge and skills depends very much on the individual motivation of the students and the specific research topic. In general, every student learns how to formulate a preliminary research question, how to approach solving this question in his/her own research area, and to write a scientific report about the results. Since you pick your own topic, you can make it fit to your track. Knowledge and skills of other courses will be applied during the field research.
Osiris shows the basic set-up and planning, however, all detailed information about logistics, research topics etc. will be provided during a short meeting organized by Hans de Bresser before the course enrollment for period 4 has started.

Assessment, structure and work load
This course has a very high work load, since as much learning as possible is crammed into only 7.5 ECTS. The structure and assessment is as follows:

May
After emailing your preferences to the staff, they compile a list of teams, research topics + area and bus division. In general, there are four areas to stay (in alphabetical order):
1. Carboneras: mainly structural geology, fault kinematics, also sedimentation & tectonics, volcanics
2. Lubrin: high PT structural geology, ductile deformation, metamorphic terrains
3. Sorbas: mainly biostratigraphy and astronomical tuning, also sedimentology & tectonics
4. Tabernas: sedimentology & tectonics, sedimentology

Housing is managed and paid for by students. Normally you share apartments/houses with 4 – 8 persons. Also food is paid by yourself. Transport to and in Spain happens with 8-person minibuses arranged by the UU, with students driving. You should prepare for the fieldwork by searching and reading relevant literature.

June
30 days traveling and fieldwork in the Betic Cordillera, SE Spain with approximately the following aspects: It starts with a 3 day field excursion with all staff and students to get an impression of the regional geology. The other ~3.5 weeks you do fieldwork in teams of two in your own research area of which 3-4 times accompanied by one of the staff members. It is your own responsibility how much time you spend in the field and in the evening processing the results. Halfway there is a 1 day volcanics excursion with the whole group.

July & September
Writing a short/paper style scientific report with your fieldwork partner about your research.

Schedule (based on fieldwork 2013):
- Deadline first version: beginning 2nd week of July
- Reviewed: beginning of September
- Deadline final version: third week of September
- Reviewed & graded: before end of September

Experiences
Most students experience the fieldwork time as an exciting, tiresome, interesting key element of their Earth Science study. The teachers do their utter best and know a lot about the fieldwork area. The atmosphere in the whole group (students ánd staff) is always great. The field research is challenging and requires a high level of commitment. You will receive a lot of feedback on the 1st version of the report, since the staff sets high standards.

1.9 Excursion physical geography (Denmark/Switzerland)

Overview

Period	4	Course code	GEO4-4418
Timeslot	First half	Mean rating last year	
Teacher	Prof Dr. Piet Hoekstra or Dr. M. van der Perk	Mean workload last year	-
Contact	J. Beltman	Success rate last year	100%

Note on forehand
The excursion is in the even years to Denmark and led by Prof. Dr. Piet Hoekstra and is focused on glacial, coastal, sedimentary and some fluvial processes. The excursion in the odd years takes place in the upper Rhine and Germany under the jurisdiction of Dr. M. van der Perk and focusses on

hydrological, fluvial and soil processes. The cost of both excursions is around 450 euros. The excursion is mostly for students of physical geography and their associated track. In case of a high amount of participants, as happened in 2012 and 2014, the teachers can decide to select on the followed track and courses.

Acquired knowledge and skills
Apart from the difference in subjects, which are described on the Osiris page, the gained knowledge and skills are mostly practical. During the excursion students learn to recognize different features in real life and understand the spatial- and timescales of different processes. Some small scale field days lead to some experience on collecting data in the field with various tools.

Assessment, structure and work load
The excursion typically takes place in the first two weeks of May. During these weeks the days are mostly spend in the field on various sites. Active participation of the students is a requirement during the day, one oral presentation is obligatory during the excursion and is assigned randomly. After the excursion a paper about an excursion site is the final part of the pass or no pass grade of the course. Compared to the other fieldworks this is a relatively easy course with a fairly low work load but with a high amount of information.

Experiences
The excursion is typically rated as fairly easy and somewhat cheap study points (despite the payment). However, the subjects are found to be very interesting with a high amount of information. This is mainly due to the visible link between processes and their results. The atmosphere is, like most excursions and fieldwork, excellent and is a major plus for the excursion.

2. Climate reconstruction

For each track you have to choose at least 5 track courses, of which at least 3 from the top box.

Track: Climate reconstruction
Paleoceanography and climate variability Reconstructing Quaternary environments Hydrology, climate change and fluvial systems Astronomical climate forcing and time scales
Microbes and biogeochemistry Organic Geochemistry *IMAU or BIO courses* Field research instruction **or** MSc excursion Physical Geography

2.1 Malou's Master Track: Climate reconstruction

"From the topbox I picked the courses: Paleoceanography and climate variability; Astronomical climate forcing and time scales, and Reconstructing Quaternary environments. Especially the astronomical course I found very useful, because I learned a lot and acquired new skills. From the additional courses I picked the Field research instruction Geology.
Furthermore I did the M-profile Earth & Sustainability, which focuses on sustainable development. The courses of this profile are part of the master program Sustainable development. From ten courses (see below) I choose the following four: Environmental ethics and sustainable development; Introduction to the energy & resource system; Themes in global change & ecosystems, and Climate systems and adaptation or Energy policy and transition. Part of this M-profile I also did an internship about climate communication. In this internship is translated scientific research for policymakers. I think the M-profile is a good addition if you want to broaden your knowledge and if you are not necessarily interested to become a fulltime researcher."

2.2 Paleoceanography and climate variability

Overview

Period	1	Course code	GEO4-1405
Timeslot	B	Mean rating last year	7.4
Teacher	Gert Jan Reichart	Mean workload last year	~16 h
Contact	g.j.reichart@uu.nl	Success rate last year	16 out of 22

Acquired knowledge and skills
Knowledge: Understanding the (paleo)ocean circulation during different climatic regimes, and the related proxy variability. The bachelor course paleoceanography focused more on the basics of understanding the ocean system. About how the physical and the chemical components of the ocean work. This master course is more applied to different climatic regimes.
Skills: improved Excel skills (computer practical).

Assessment, structure and work load
Two days in the week you have two hour lecture, followed by two hour computer practical about the lecture subject. You have to hand in these practicals every week, which will be graded. There is a final exam which count for 70% of your grade. Because you have to hand in the practical every week, the workload is quite evenly distributed.

Experiences
The course is well organized. Lucas Lourens and Martin Ziegler also gave some lectures. The structure of lectures followed by computer practicals about the same topic works really good. There was also enough guidance during the practicals and you received every week feedback on your previous assignment.

2.3 Reconstructing quaternary environments

Overview

Period	2	Course code	GEO4-4409
Timeslot	C	Mean rating last year	7,4
Teacher	Wim Hoek	Mean workload last year	~10 h
Contact	w.hoek@geo.uu.nl	Success rate last year	18 out of 18

Acquired knowledge and skills
Knowledge: Understanding how the Quaternary climate and environment changed and how you can reconstruct the environment. Thus understanding different kind of proxies and dating techniques.
Skills: Using different kind of proxies and techniques to reconstruct the Quaternary environment and climate. Amongst others using pollen to recognize species and reconstruct the environment.

Assessment, structure and work load
There course consists of lectures and practicals every week.
The exam at the end counts for 70% of the final grade. The remaining 30% of the grade is composed of a written paper (15%) and presentation (15%). The workload of the course is not very heavy.

Experiences
This course is actually a combination between biogeology and physical geography. The focus is on climatic and environmental change, which is part of biogeology. But the timeframe is the Quaternary and the method is to use characters of physical geography to identify the change. For example, there is a lot of attention to pingo's. So although the level of this course was not very challenging, it broadens the knowledge. For the track of climate reconstruction it is useful to also have knowledge of this physical geography part for identifying climate change. These are features which you can usually identify easy in the landscape but are not covered in other courses, because it is only suitable for a relatively short timescale. I liked to have a more physical geography course and focus on other features. For example the practical about using pollen proxies I found nice.
We also had an excursion to TNO; some guest lectures and a practical in dendrology at an institute in Amersfoort. This was very nice and good organized.

2.4 Hydrology, climate change and fluvial systems

Overview

Period	4	Course code	GEO4-4423
Timeslot	nvt	Mean rating last year	7,7
Teacher	Prof dr. M.F.P.Bierkens	Mean workload last year	~18 h
Contact	M.F.P.Bierkens@uu.nl	Success rate last year	10 out of 11

Although this course is part of the topbox of the track of 'Climate reconstruction', 100% of the students were from the track of Earth, Surface and Water (year 2012/2013). So for the course description see the track Earth, Surface and Water. This is of course not a limitation to follow this course in this track.

Acquired knowledge and skills
Knowledge: The course focuses on the connection of climate (change) with hydrology. Students get to know the most recent research on climate, and the effect of climate change on hydrological patterns (evaporation, precipitation, ice melt) and vice versa (via feedback loops). Also research methods are treated (remote sensing, measurement equiptment etc).
Skills: Depending on your paper subject. You are free to choose every subject relating to climate and/or hydrology. You can also choose a model study or a small fieldwork (which you have to arrange yourself).

Assessment, structure and work load
This course is a series of colloquia, with many lectures of guest speakers. Every morning (9:30-12:00) students are required to be present at the lectures. There are three computer practicals which have to be handed in to be graded, but most of the time these practicals are in the morning, too. You have to write a course synopsis at the end. The grading differs: For 4 ECTS: course synopsis (50%) and computer practicals (50%); For 7.5 ECTS: course synopsis (25%), computer practicals (25%), paper (50%). In practice almost every student writes a paper (of which the deadline is end of September).

Experiences
The experiences differ per day, as the quality of the teachers and the background knowledge of the students differ per subject. Lectures about the atmospheric system are quite new, whereas students already know much of other subjects. Overall, the work load depends on your own choice, as you don't need to do much if you don't spend much time on the paper.

2.5 Astronomical climate forcing and time scales

Overview

Period	2	Course code	GEO4-1412
Timeslot	B	Mean rating last year	7.7
Teacher	Frits Hilgen	Mean workload last year	~18 h
Contact	f.j.hilgen@uu.nl	Success rate last year	

Acquired knowledge and skills
Knowledge: This course gives you more understanding of climate variability. In particular how astronomical cycles influence climate. You gain advanced knowledge about the Milankovitch cycles: their origin and how they influence climate.
Skills: Improved Excel skills during the computer practicals. You also make your own geological time-scale during one of the practicals. Another skill you gain in this course is to recognize astronomical cycles in a sedimentary record.

Assessment, structure and work load
The course is structured by lectures and computer practicals. Furthermore the course has a midterm test (20% of the final grade) and a final test (45% of the final grade). The remaining 35% of the grade is equally divided over an essay and oral presentation. The work load is evenly spread.

Experiences

The course was good organized and very useful for my program. I learned a lot during this course and acquired new skills. I really understand the mechanism of astronomical cycles influencing climate a lot better. Frits Hilgen is also a very dedicated teacher with interactive lectures and supplying summaries of the lectures for the exam.

2.6 Microbes and biogeochemistry

Overview

Period	1	Course code	GEO4-1440
Timeslot	C	Mean rating last year	7.6
Teacher	Jack Middelburg and Martin Thullner	Mean workload last year	
Contact	j.b.m.middelburg@uu.nl	Success rate last year	13 out of 13

Acquired knowledge and skills
Knowledge: This is quite a chemical orientated course. It focuses on the pathways of the main elements present in the ocean and how biogeochemical processes interact with this. The course also has a biological aspect in which you learn different types of microbiological organisms such as bacteria/ plankton and archaea ect.
Skills: You gain a more in-depth picture of the biogeochemical processes happening in the oceans and ocean sediments.

Assessment, structure and work load
The workload of this course is average, although the information density is quite high. Every week you have lectures (often 3 or 4 hours a day!) and near the end of the period there are a few computer practicals too. The assessment of the course is as follows: Term paper (15%); presentations (15%); final examination (70%).

Experiences
It was nice to learn more about microbes / microbiology in an aquatic setting as, even though as a paleoclimatologist/chemist you may easily forget this, they play a major role in biogeochemical processes taking place in the sediment!

2.7 Organic geochemistry

Overview

Period	4	Course code	GEO4-1420
Timeslot	--	Mean rating last year	6.9
Teacher	prof. dr. J.S. Sinninghe Damste	Mean workload last year	
Contact	J.S.SinningheDamste@uu.nl	Success rate last year	13 out of 15

Acquired knowledge and skills
Knowledge: An introduction into organic geochemistry. You learn what happens to organic material when it enters the sediment column (ie. diagenetic processes), and how it is useful in reconstructing paleo-climates and environments. The lectures consist of an overview of different biomarkers.
Skills: You learn the chemical background / structures of the biomarkers (which are used for the paleoclimatic and paleoenvironmental reconstructions). Furthermore, there are a few lab sessions during the course in which you can acquire some lab-experience in this field.

Assessment, structure and work load
The course is full-time (about 4 days a week, but the schedule varies) for only the first half of the 4th period. This is so that this course can easily be combined with fieldwork courses in the second half of

the 4th period. The course mainly consists of lectures but there are a few practical aspects too (presentation, lab session, excursion to Shell). The course has a fast pace and a high information density. However, as this course is the only one you will follow these few weeks, you have enough time to keep up too.

Experiences
I really enjoyed this course. It opened a new window for me – in which biomarkers can also be used for paleoclimatic reconstructions. This field is relatively new and quickly evolving, which makes it an exciting environment to discover. Also, the overlap with other courses was very limited and almost all study material was new for me, which made me feel that this course was very valuable to follow. Just before the exam, there was also the possibility to visit Shell in Rijswijk as a career orientation and to see how organic geochemistry is used in the oil industry. This was a great opportunity to broaden my view of this discipline.

2.8 Field research instruction geology (Spain)

Overview

Period	4	Course code	GEO4-1430
Timeslot	Second half	Mean rating last year	8.2
Teacher	J.H.P de Bresser F.J. Hilgen Liviu Matenco	Mean workload last year	
Contact		Success rate last year	33 out of 33

Acquired knowledge and skills
For this field course, the amount and type of acquired knowledge and skills depends very much on the individual motivation of the students and the specific research topic. In general, every student learns how to formulate a preliminary research question, how to approach solving this question in his/her own research area, and to write a scientific report about the results. Since you pick your own topic, you can make it fit to your track. Knowledge and skills of other courses will be applied during the field research.
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Assessment, structure and work load
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After emailing your preferences to the staff, they compile a list of teams, research topics + area and bus division. In general, there are four areas to stay (in alphabetical order):
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2.9 Excursion physical geography (Denmark/Switzerland)

Overview

Period	4	Course code	GEO4-4418
Timeslot	First half	Mean rating last year	
Teacher	Prof Dr. Piet Hoekstra or Dr. M. van der Perk	Mean workload last year	-
Contact	J. Beltman	Success rate last year	100%

Note on forehand
The excursion is in the even years to Denmark and led by Prof. Dr. Piet Hoekstra and is focused on glacial, coastal, sedimentary and some fluvial processes. The excursion in the odd years takes place in the upper Rhine and Germany under the jurisdiction of Dr. M. van der Perk and focusses on hydrological, fluvial and soil processes. The cost of both excursions is around 450 euros. The excursion is mostly for students of physical geography and their associated track. In case of a high amount of participants, as happened in 2012 and 2014, the teachers can decide to select on the followed track and courses.

Acquired knowledge and skills
Apart from the difference in subjects, which are described on the Osiris page, the gained knowledge and skills are mostly practical. During the excursion students learn to recognize different features in real life and understand the spatial- and timescales of different processes. Some small scale field days lead to some experience on collecting data in the field with various tools.

Assessment, structure and work load

The excursion typically takes place in the first two weeks of May. During these weeks the days are mostly spend in the field on various sites. Active participation of the students is a requirement during the day, one oral presentation is obligatory during the excursion and is assigned randomly. After the excursion a paper about an excursion site is the final part of the pass or no pass grade of the course. Compared to the other fieldworks this is a relatively easy course with a fairly low work load but with a high amount of information.

Experiences

The excursion is typically rated as fairly easy and somewhat cheap study points (despite the payment). However, the subjects are found to be very interesting with a high amount of information. This is mainly due to the visible link between processes and their results. The atmosphere is, like most excursions and fieldwork, excellent and is a major plus for the excursion.

3. Biogeosciences and evolution

For each track you have to choose at least 5 track courses, of which at least 3 from the top box.

Track: Biogeosciences and evolution
Evolutionary paleobiology and proxies Organic Geochemistry Microbes and biogeochemistry Vertebrate evolution (tetrapods)
Dynamics of sedimentary systems Aquatic and environmental geochemistry * Astronomical climate forcing and time scales * Field research instruction geology / geochemistry * and/or BIO courses

3.1 Evolutionary paleobiology and proxies

Overview

Period	3	Course code	GEO4-1422
Timeslot	B	Mean rating last year	7.8
Teacher	Ivo Duijnstee, Jelle Reumer	Mean workload last year	~15 h
Contact	i.a.p.duijnstee@uu.nl	Success rate last year	96%

Acquired knowledge and skills
Knowledge: The lectures of this course dealt with statistical analysis of biological proxies on the one hand and important issues/trends in evolution (such as mass extinctions) on the other.
Skills: Applying statistics to data sets of foraminiferal assemblages

Assessment, structure and work load
The course is set up with lectures and practicals. The workload of this course is quite low compared to other MSc courses. The final mark consists for 50% op practicals and 50% of a written exam.

Experiences
The lectures of this course dealt with statistical analysis of biological proxies on the one hand and important issues/trends in evolution (such as mass extinctions) on the other. The practicals mostly consisted of applying statistics to data sets of foraminiferal assemblages. Getting acquired with some statistical procedures was nice, but the practicals were quite dull. However, the lectures were of excellent quality, with the importance of critical thinking as a subtly recurring theme. The workload of this course is quite low compared to other MSc courses. All in all, I do not think that the course was of great significance for my track (Integrated Stratigraphy and Sedimentary Systems), but I would like to point out that the lectures were interesting and instructive for everyone. For that reason I am still glad that I attended the course.

3.2 Organic geochemistry

Overview

Period	4	Course code	GEO4-1420
Timeslot	--	Mean rating last year	6.9
Teacher	prof. dr. J.S. Sinninghe Damste	Mean workload last year	
Contact	J.S.SinninghеDamste@uu.nl	Success rate last year	13 out of 15

Acquired knowledge and skills
Knowledge: An introduction into organic geochemistry. You learn what happens to organic material when it enters the sediment column (ie. diagenetic processes), and how it is useful in reconstructing paleo-climates and environments. The lectures consist of an overview of different biomarkers.
Skills: You learn the chemical background / structures of the biomarkers (which are used for the paleoclimatic and paleoenvironmental reconstructions). Furthermore, there are a few lab sessions during the course in which you can acquire some lab-experience in this field.

Assessment, structure and work load
The course is full-time (about 4 days a week, but the schedule varies) for only the first half of the 4th period. This is so that this course can easily be combined with fieldwork courses in the second half of the 4th period. The course mainly consists of lectures but there are a few practical aspects too (presentation, lab session, excursion to Shell). The course has a fast pace and a high information density. However, as this course is the only one you will follow these few weeks, you have enough time to keep up too.

Experiences
I really enjoyed this course. It opened a new window for me – in which biomarkers can also be used for paleoclimatic reconstructions. This field is relatively new and quickly evolving, which makes it an exciting environment to discover. Also, the overlap with other courses was very limited and almost all study material was new for me, which made me feel that this course was very valuable to follow. Just before the exam, there was also the possibility to visit Shell in Rijswijk as a career orientation and to see how organic geochemistry is used in the oil industry. This was a great opportunity to broaden my view of this discipline.

3.3 Microbes and biogeochemistry

Overview

Period	1	Course code	GEO4-1440
Timeslot	C	Mean rating last year	7.6
Teacher	Jack Middelburg and Martin Thullner	Mean workload last year	
Contact	j.b.m.middelburg@uu.nl	Success rate last year	13 out of 13

Acquired knowledge and skills
Knowledge: This is quite a chemical course. It focuses on the pathways of the main elements present in the ocean and how biogeochemical processes interact with this. The course also has a biological aspect in which you learn different types of microbiological organisms such as bacteria/ plankton and archaea ect.
Skills: You gain a more in-depth picture of the biogeochemical processes happening in the oceans and ocean sediments.

Assessment, structure and work load
The workload of this course is average, although the information density is quite high. Every week you have lectures (often 3 or 4 hours a day!) and near the end of the period there are a few

computer practicals too. The assessment of the course is as follows: Term paper (15%); presentations (15%); final examination (70%).

Experiences
It was nice to learn more about microbes / microbiology in an aquatic setting as, even though as a paleoclimatologist/chemist you may easily forget this, they play a major role in biogeochemical processes taking place in the sediment!

3.4 Vertebrate evolution (tetrapods)

Overview

Period	2	Course code	GEO4-1514B
Timeslot	A	Mean rating last year	7.6
Teacher	W. Wessels en Jelle Reumer	Mean workload last year	
Contact	Dr. w.wessels@uu.nl	Success rate last year	13 out of 13

Acquired knowledge and skills
Knowledge: Nearly the entire evolutionary history of vertebrate species is covered in this course. Through this a broad but yet detailed knowledge of vertebrate knowledge is obtained. Specifically the changes that can be observed in the skull are brought into focus and their relation to changes in the habitat.
Skills: Identifying fossil remains and determining their habitats.

Assessment, structure and work load
A two-hour lecture and four hour practical are spread over two days. At the end of course you are required to write a summarizing report of the practicals, which is graded. Furthermore a presentation and essay are required on a (freely) chosen topic. The presentations take place about halfway through the course.
The final exam consists of two parts. An exam on skeletal and dentary features followed by an open book exam on the whole course.
The workload isn't staggering and well-spread over the course.

Experiences
The lectures are interesting, not only due to the content but also due to the qualities of the lecturers. The practicals greatly enhance the knowledge of species determination and are well supervised. Overall this is a fun and interesting class. It is not difficult to end this course with a good grade as long as you spend enough time on reading the material and writing the reports.

3.5 Dynamics of sedimentary systems

Overview

Period	3	Course code	GEO4-1419
Timeslot	D	Mean rating last year	7.9
Teacher		Mean workload last year	
Contact		Success rate last year	

Acquired knowledge and skills
The main thing learned in this course is relating different types of models to one another. This includes numerical models, physical models and conceptual models. The knowledge acquired about modelling and how to value and relate different models could be also very useful in other fields of

(earth) science. This is of course done in the setting of sedimentary systems, of which a lot is learned mainly by reading and discussing high-quality papers.

Assessment and work-load

The course is constructed of lectures, numerical modelling labs and physical modelling in the Eurotank, of which reports are expected to be handed in. There also is a team-project in which a research proposal is written and presented. The work-load is moderate to high in comparison to other courses. Due to the team project at the end of the course the main weight of the work is experienced during the last few weeks.

Experiences

Both Joris and Paul are very pleasant lecturers to listen to and explain things very clearly. During Joris' lectures the focus will be on physical modelling of sedimentary systems, and the general concepts behind sedimentology and sedimentary geology. During Paul's lectures the focus will be on the mathematical description of sedimentary processes and basic numerical modelling will be applied during the computer labs. Due to a relatively small group of students (20-25 in '12-'13), the lecturers are very approachable. During the course there also is a three-day field trip to northern France in which the concepts learned in class can be seen in the field, the trip is a lot of fun! *In 2013-2014 this fieldtrip was cancelled because the lecturers did not have time.*

3.6 Aquatic and environmental geochemistry

Overview

Period	1	Course code	GEO4-1439
Timeslot	A	Mean rating last year	8.3
Teacher	Dh. T. Behrends	Mean workload last year	15 h
Contact	AW W136 t.behrends@uu.nl	Success rate last year	33%

No entry requirements and the course is also not an entry requirement for another course.

Acquired knowledge and skills

Knowledge: The course is about the processes (equilibrium) that control the composition of different water bodies. The processes are: acid base reactions, redox reactions, solubility of solids, metal speciation in aqueous solution, distribution of compounds between different phases and the adsorption of ions and organic compounds at the solid-liquid interface.
Basic knowledge of equilibrium thermodynamics is useful (course: Physical Chemistry GEO2-1202)
Skills: You also learn how to work with MINEQL 4.6, which is a chemical equilibrium speciation model.

Assessment, structure and work load

Every week a new topic is started. The topics are: acid base chemistry, metal speciation, redox chemistry, gas water equilibrium, solid solution equilibrium and solid water interface. So there is a nice structure.
There are three short reports that need to be made that are spread well over the period. The reports are about assignments that need to be done by MINEQL 4.6.

Experiences

The lectures are written on the blackboard. This means that the slides only have pictures and graphs on them without any text. So it is clever to be present at the lectures and to make notes!
At the beginning of every new topic you will get a handout with questions that will be answered and the different subjects that will be told. This is nice when preparing for the exam, you know what will expected from you and it is nice when preparing for the exam.

Tip 1.) You may use two A4 sheets with notes during the exam. Use them good, write so many things on it as you can. It really helps remembering the subject matter and you do not need to learn anything by hard.
Tip 2.) Look at the older exams they all have the same structure and topics, so take that advantaged!

3.7 Astronomical climate forcing and time scales

Overview

Period	2	Course code	GEO4-1412
Timeslot	B	Mean rating last year	7.7
Teacher	Frits Hilgen	Mean workload last year	~18 h
Contact	f.j.hilgen@uu.nl	Success rate last year	

Acquired knowledge and skills
Knowledge: This course gives you more understanding of climate variability. In particular how astronomical cycles influence climate. You gain advanced knowledge about the Milankovitch cycles: their origin and how they influence climate.
Skills: Improved Excel skills during the computer practicals. You also make your own geological time-scale during one of the practicals. Another skill you gain in this course is to recognize astronomical cycles in a sedimentary record.

Assessment, structure and work load
The course is structured by lectures and computer practicals. Furthermore the course has a midterm test (20% of the final grade) and a final test (45% of the final grade). The remaining 35% of the grade is equally divided over an essay and oral presentation. The work load is evenly spread.

Experiences
The course was good organized and very useful for my program. I learned a lot during this course and acquired new skills. I really understand the mechanism of astronomical cycles influencing climate a lot better. Frits Hilgen is also a very dedicated teacher with interactive lectures and supplying summaries of the lectures for the exam.

3.8 Field research geology

Overview

Period	4	Course code	GEO4-1430
Timeslot	Second half	Mean rating last year	8.2
Teacher	J.H.P de Bresser F.J. Hilgen Liviu Matenco	Mean workload last year	
Contact		Success rate last year	33 out of 33

Acquired knowledge and skills
For this field course, the amount and type of acquired knowledge and skills depends very much on the individual motivation of the students and the specific research topic. In general, every student learns how to formulate a preliminary research question, how to approach solving this question in his/her own research area, and to write a scientific report about the results. Since you pick your own topic, you can make it fit to your track. Knowledge and skills of other courses will be applied during the field research.

Osiris shows the basic set-up and planning, however, all detailed information about logistics, research topics etc. will be provided during a short meeting organized by Hans de Bresser before the course enrollment for period 4 has started.

Assessment, structure and work load
This course has a very high work load, since as much learning as possible is crammed into only 7.5 ECTS. The structure and assessment is as follows:

May
After emailing your preferences to the staff, they compile a list of teams, research topics + area and bus division. In general, there are four areas to stay (in alphabetical order):
1. Carboneras: mainly structural geology, fault kinematics, also sedimentation & tectonics, volcanics
2. Lubrin: high PT structural geology, ductile deformation, metamorphic terrains
3. Sorbas: mainly biostratigraphy and astronomical tuning, also sedimentology & tectonics
4. Tabernas: sedimentology & tectonics, sedimentology

Housing is managed and paid for by students. Normally you share apartments/houses with 4 – 8 persons. Also food is paid by yourself. Transport to and in Spain happens with 8-person minibuses arranged by the UU, with students driving. You should prepare for the fieldwork by searching and reading relevant literature.

June
30 days traveling and fieldwork in the Betic Cordillera, SE Spain with approximately the following aspects: It starts with a 3 day field excursion with all staff and students to get an impression of the regional geology. The other ~3.5 weeks you do fieldwork in teams of two in your own research area of which 3-4 times accompanied by one of the staff members. It is your own responsibility how much time you spend in the field and in the evening processing the results. Halfway there is a 1 day volcanics excursion with the whole group.

July & September
Writing a short/paper style scientific report with your fieldwork partner about your research.

Schedule (based on fieldwork 2013):
- Deadline first version: beginning 2nd week of July
- Reviewed: beginning of September
- Deadline final version: third week of September
- Reviewed & graded: before end of September

Experiences
Most students experience the fieldwork time as an exciting, tiresome, interesting key element of their Earth Science study. The teachers do their utter best and know a lot about the fieldwork area. The atmosphere in the whole group (students ánd staff) is always great. The field research is challenging and requires a high level of commitment. You will receive a lot of feedback on the 1st version of the report, since the staff sets high standards.

3.9 Excursion physical geography (Denmark/Switzerland)

Overview

Period	4	Course code	GEO4-4418
Timeslot	First half	Mean rating last year	
Teacher	Prof Dr. Piet Hoekstra or Dr. M. van der Perk	Mean workload last year	-

Contact	J. Beltman	Success rate last year	100%

Note on forehand
The excursion is in the even years to Denmark and led by Prof. Dr. Piet Hoekstra and is focused on glacial, coastal, sedimentary and some fluvial processes. The excursion in the odd years takes place in the upper Rhine and Germany under the jurisdiction of Dr. M. van der Perk and focusses on hydrological, fluvial and soil processes. The cost of both excursions is around 450 euros. The excursion is mostly for students of physical geography and their associated track. In case of a high amount of participants, as happened in 2012 and 2014, the teachers can decide to select on the followed track and courses.

Acquired knowledge and skills
Apart from the difference in subjects, which are described on the Osiris page, the gained knowledge and skills are mostly practical. During the excursion students learn to recognize different features in real life and understand the spatial- and timescales of different processes. Some small scale field days lead to some experience on collecting data in the field with various tools.

Assessment, structure and work load
The excursion typically takes place in the first two weeks of May. During these weeks the days are mostly spend in the field on various sites. Active participation of the students is a requirement during the day, one oral presentation is obligatory during the excursion and is assigned randomly. After the excursion a paper about an excursion site is the final part of the pass or no pass grade of the course. Compared to the other fieldworks this is a relatively easy course with a fairly low work load but with a high amount of information.

Experiences
The excursion is typically rated as fairly easy and somewhat cheap study points (despite the payment). However, the subjects are found to be very interesting with a high amount of information. This is mainly due to the visible link between processes and their results. The atmosphere is, like most excursions and fieldwork, excellent and is a major plus for the excursion.

4. Environmental geochemistry

For each track you have to choose at least 5 track courses, of which at least 3 from the top box.

Track: Environmental geochemistry
Aquatic and environmental geochemistry Reactive transport in the hydrosphere Kinetic Processes Environmental hydrogeology
Hydrogeological transport phenomena Microbes and biogeochemistry Principles of groundwater flow Mineral and isotope tracers of Earth processes Field research instruction geochemistry

4.1 Aquatic and environmental geochemistry

Overview

Period	1	Course code	GEO4-1439
Timeslot	A	Mean rating last year	8.3
Teacher	Dh. T. Behrends	Mean workload last year	15 h
Contact	AW W136 t.behrends@uu.nl	Success rate last year	33%

No entry requirements and the course is also not an entry requirement for another course.

Acquired knowledge and skills
Knowledge: The course is about the processes (equilibrium) that control the composition of different water bodies. The processes are: acid base reactions, redox reactions, solubility of solids, metal speciation in aqueous solution, distribution of compounds between different phases and the adsorption of ions and organic compounds at the solid-liquid interface.
Basic knowledge of equilibrium thermodynamics is useful (course: Physical Chemistry GEO2-1202)
Skills: You also learn how to work with MINEQL 4.6, which is a chemical equilibrium speciation model.

Assessment, structure and work load
Every week a new topic is started. The topics are: acid base chemistry, metal speciation, redox chemistry, gas water equilibrium, solid solution equilibrium and solid water interface. So there is a nice structure.
There are three short reports that need to be made that are spread well over the period. The reports are about assignments that need to be done by MINEQL 4.6.

Experiences
The lectures are written on the blackboard. This means that the slides only have pictures and graphs on them without any text. So it is clever to be present at the lectures and to make notes!

At the beginning of every new topic you will get a handout with questions that will be answered and the different subjects that will be told. This is nice when preparing for the exam, you know what will expected from you and it is nice when preparing for the exam.

Tip 1.) You may use two A4 sheets with notes during the exam. Use them good, write as many things on it as you can. It really helps remembering the subject matter and you do not need to learn anything by hard.
Tip 2.) Look at the older exams they all have the same structure and topics, so take that advantaged!

4.2 Reactive transport in the hydrosphere

Overview

Period	3	Course code	GEO4-1421
Timeslot	D	Mean rating last year	8.5
Teacher	prof. dr. ir. C.P. Slomp dr. L. Polerecky	Mean workload last year	16 h
Contact	c.p.slomp@uu.nl AW W132	Success rate last year	100 %

Obligated book: Soetaert, K. and P.M.J. Herman, 2009. A practical guide to ecological modelling using R as a simulation platform. Springer. ISBN: 978-1-4020-8623-6. ca. 70 euro. (also as pdf on internet)

Acquired knowledge and skills
Knowledge: At the beginning of the course relatively simple (bio)geochemical reactions are treated, while towards the end of the course also transport processes become more complex. Also theory about modelling is subject of the course (steady states, how to solve differential equations analytically, boundary conditions).
Skills: Students get experience with modeling with R.

Assessment, structure and work load
The course starts with the basics of modeling. Lectures are about modeling, numerical and analytical solutions, stability and feedback, and during practicals students work with R from the basis towards more difficult exercises with these subjects. Some of the practicals are graded. At the end of the course students will choose a case study. For their topic they individually have to make a model, with report and presentation . There is also a hydrological guest lecture. The structure and work load are well balanced.

Experiences
Students like to start the modeling from the basis. The book is good. Some people from the track Hydrology think it's too less hydrology, because it is mainly about modelling the dynamics in the ocean and the ocean's sediment. Especially if you're interested in earth surface hydrology, the topics in this course don't fit to your interests.

4.3 Kinetic processes

Overview

Period	2	Course code	GEO4-1426
Timeslot	A	Mean rating last year	6.8
Teacher	Dr. T. Behrends	Mean workload last year	16 h

	Prof. dr. C.J. Spiers		
Contact	AW W136 t.behrends@uu.nl	Success rate last year	100 %

No entry requirements and the course is also not an entry requirement for another course.

Acquired knowledge and skills

Knowledge: You learn how to derive and apply quantitative expressions for describing the rates of biogeochemical processes, like Michaelis-Menten kinetics and the Arrhenius equation. Also the transition state theory will be explained (two weeks) and used. A few weeks before the exam dr. Spiers will teach one week, about kinetic processes in rock-fluid systems under non-hydrostatic conditions.
Skills: You will work with Excel.

Assessment, structure and work load

In the weeks before the Christmas break you will have graded assignments as homework. In the last two weeks before the Christmas break (so four lectures) there are guest lectures from Lubos Polerecky about statistical thermodynamics (which relates to the transition state theory). Directly after the Christmas break you will do a presentation of 45 minutes in groups of two. The presentation will cover a whole week of lectures. This presentation needs to be made in the Christmas break. After the week with presentation, you will get the contribution of Chris Spiers. The last week there is a guest lecture of Niels de Hartog (geochemical hydrogeologist).

Experiences

The variety of the course and the different aspects is nice. You see that kinetic processes are very important in many fields.
The lectures given by Thilo are written on the blackboard. This means that the slides only have pictures and graphs on them without any text. So it is clever to be present at the lectures and to make notes!
The homework assignments from Zhangs textbook (which will be online on blackboard) are not strongly related to the lectures. This makes them difficult.

Tip 1.) You may use two A4 sheets with notes during the exam. Use them good, write so many things on it as you can. It really helps remembering the subject matter and you do not need to learn anything by hard.

Tip 2.) For the homework exercises some of the answers are presented at the back of the book. So that you can check if it is correct.

4.4 Environmental hydrogeology

Overview

Period	4	Course code	GEO4-1432
Timeslot	First half	Mean rating last year	
Teacher	A. Raoof, prof. dr. ir. S.M. Hassanizadeh, prof. dr. R.J. Schotting and some guest lecturers	Mean workload last year	
Contact	A. Raoof@uu.nl	Success rate last year	

Acquired knowledge and skills

Knowledge: The course continues where Hydrogeological transport phenomena and Principles of groundwater flow stop. Lectures are given on several topics, such as the transport of organic liquids, viruses and heat. Also the basis of multiphase flow and remediation techniques are treated.
Skills: Students have to work with modeling programs Hydrus 1D and PMWIN Modflow.

Assessment, structure and work load
The course is full-time, which means almost every day you have a lecture of a couple of hours. Next to several small exercises, one big modeling exercise has to be done in groups of three with Modflow. For this exercise you first go on an "excursion" to a pollution site. You thus have to model a real part of the soil, so you also have to deal with not knowing required parameters etc. Next to the large modeling exercise (25% of your grade), you have to do a presentation about your thesis subject (together with homework 25% of grade) and a take home exam (50%). The work load increases during the five weeks of the course.

Experiences
The variety of lectures and practicals and all different teachers and subjects is appreciated. It feels like applying your knowledge that you gained in other courses to real problems. The take home exam last year didn't cover all subjects, which was a pity and therefore a little easy.

4.5 Hydrogeological transport phenomena

Overview

Period	2	Course code	GEO4-1433
Timeslot	D	Mean rating last year	8.1
Teacher	prof. dr. ir. S.M. Hassanizadeh	Mean workload last year	19
Contact	s.m.hassanizadeh@uu.nl AW W228	Success rate last year	93 %

Book: Mayer, A.S. and S.M. Hassanizadeh, Soil and Groundwater Contamination: Nonaqueous Phase Liquids, American Geophysical Union, 224 pages, June 2005 (ISBN 0-87590-321-7). (recommended)
Book: Fetter, C.W., Contaminant hydrogeology, Macmillan, New York, (2nd ed.). 1999. (recommended)
Required course: AW-Principles of groundwater flow (GEO4-1434).

Acquired knowledge and skills
Knowledge: The course starts with laws about dissolution and volatilization and continues with flow and transport equations: advection, degradation/decay, diffusion, dispersion and adsorption. At the end of the course there is a lecture about transport in the unsaturated zone. The course fits in a sequence of courses of increasing level: Principles of Groundwater Flow (Period 1), Hydrogeological Transport Phenomena and Environmental Hydrogeology (Period 4).
Skills: In this course students learn how to come up and work out flow and transport equations for different situations and different initial and boundary conditions. The mathematical level is high. Students learn to think themselves, for example if you think a value is missing in the exercise, you have to search on the internet for an appropriate value yourself. Also transport modeling in Modflow is a topic. During the lectures there is referred to real problems and applications.

Assessment, structure and work load
Two times a week four hours lecture. Some exercises are included in the lectures. Every week students have to hand in assignments, which are graded. The work load was balanced, on average

students spend . These assignments are of equal or higher level than the exercises in the lecture. There also is an excursion to a contamination site, with a guest lecture, about which you have to hand in a report. Another guest lecture at the end of the course covers virus transport.

Experiences
Students think the didactical quality of Majid Hassanizadeh is very high. Students think the course is very instructive and of high level. The lecture notes of Majid, which he sends to every student, are good. You are allowed to use them during the final exam. Overall, students get relatively low grades for their final exam, but the grades of the assignments compensate for this.

4.6 Microbes and biogeochemistry

Overview

Period	1	Course code	GEO4-1440
Timeslot	C	Mean rating last year	7.6
Teacher	Jack Middelburg and Martin Thullner	Mean workload last year	
Contact	j.b.m.middelburg@uu.nl	Success rate last year	13 out of 13

Acquired knowledge and skills
Knowledge: This is quite a chemical course. It focuses on the pathways of the main elements present in the ocean and how biogeochemical processes interact with this. The course also has a biological aspect in which you learn different types of microbiological organisms such as bacteria/ plankton and archaea ect.
Skills: You gain a more in-depth picture of the biogeochemical processes happening in the oceans and ocean sediments.

Assessment, structure and work load
The workload of this course is average, although the information density is quite high. Every week you have lectures (often 3 or 4 hours a day!) and near the end of the period there are a few computer practicals too. The assessment of the course is as follows: Term paper (15%); presentations (15%); final examination (70%).

Experiences
It was nice to learn more about microbes / microbiology in an aquatic setting as, even though as a paleoclimatologist/chemist you may easily forget this, they play a major role in biogeochemical processes taking place in the sediment!

4.7 Principles of groundwater flow

Overview

Period	1	Course code	GEO4-1434
Timeslot	D	Mean rating last year	7.8
Teacher	prof. dr. R.J. Schotting	Mean workload last year	16-20 h
Contact	r.j.schotting@uu.nl AW W234	Success rate last year	-

Book: Charles R. Fitts, Groundwater science. Academic press, June 2002. ISBN 0-12-257855-4. (obligated)
Principles of Groundwater flow and Land Surface Hydrology (GEO4-4404) are “obligated” for master students with the track Hydrology. One of them or both courses are often required for subsequent

hydrology courses. Principles of Groundwater flow is also part of the master Water Science and Management.

Acquired knowledge and skills
Knowledge: The course gives a good overview of the basic principles to quantify flow of water through saturated porous media. All different subjects (porous media properties, flow equations, field tests etc.) are given on Osiris. A difference between Osiris and the actual course is that no attention is paid to solute transport and there is no excursion to a groundwater remediation site (this excursion is part of the course Hydrogeological Transport Phenomena GEO4-1433).
Many applications of the obtained knowledge are discussed. An introduction to the groundwater modeling program Modflow is given by Amir Raoof. Also an excursion to the drinking water company Oasen is part of the program.
Skills: The main skill you obtain is to set up and work out groundwater equations for different situations. Mathematics (differentials, super position principle etc.) is important during the whole course.

Assessment, structure and work load
Lectures cover the main part of the course. There are no practicals; students exercise by making their homework. Each part of the homework contributes to the final grade. Every homework exercise has the same weighing, while the homework assignments in the end of the course definitely take more time than the first couple of homework assignments. The workload at the end of the course is therefore higher than in the first weeks of the course.
Next to the tutorials, there are some Modflow classes and an excursion to the drinking water company Oasen. No presentation, no papers to read or to write.
Students following Principles of Groundwater Flow have a very different background. Students who do the track Hydrology from the master Earth Surface and Water often have a bachelor Earth Sciences. They followed Water in GEO processes and Physical Hydrology, have a good background and know mathematics well. For them, the work load is quite low and the learning curve is slow. The larger part of the students is from the master Water Science and Management. Their background and knowledge of mathematics (from Wageningen, Environmental Studies, HBO etc.) is often not sufficient. Ruud Schotting gives extra math classes. However, still the work load for them is very high. The difference between the math levels of the students makes the lectures hard: too slow for one part, while the other part thinks it's too difficult.

Experiences
In the course evaluations, students react very enthusiastic about the teacher. Students like the examples from reality. In the end of the course, old exams are part of the homework, which definitely helps students to exercise and prepare for the final exam.

4.8 Mineral and isotope tracers of Earth processes

Overview

Period	3	Course code	GEO4-1417
Timeslot	C	Mean rating last year	7.1
Teacher	Dr. M.J. van Bergen; dr. M.R. Drury	Mean workload last year	
Contact	M.R.Drury@uu.nl	Success rate last year	

Acquired knowledge and skills
Knowledge: The main focus lies in application of (stable) isotope dating methods, which can be used for dating and tracing rocks and processes. A recap about trace element distribution in magma and rocks is necessary to understand mixing models regarding volcanics. Knowledge about the

geodynamics of mantle convection and geochemical analysis of rocks gives a wide view of the evolution of the asthenosphere/atmosphere/lithosphere-interaction. Many machines and apparatus used in the field are introduced and explained.
Skills: Critical thinking regarding scientific papers and writing one yourself. Osiris gives quite an accurate description of the course; the knowledge about quantitative modeling is however not integrated in the course. The course fits well in the Earth Structure and Dynamics Master and Earth Materials track.

Assessment and work load
The course was taught by Manfred van Bergen (for the magmatics and isotopes) and Olivier Plumper (for the mineral fluid reactions and apparatus). Lectures with tutorials were combined. Exercises needed to be handed in in combination with a written test at the end of the course. Each week a homework exercise had to be handed in for gradation. The work load was balanced but heavy, due to a lot of scientific paper reading and exercises.

Experiences
The course was well-organized by the combination of two teachers. However, it lacked feedback on my weekly handed in exercises. Several students complained about this in the course evaluation. The different parts do complement each other well in the combination of the litho-/asthenosphere geodynamics with the hydrosphere reactions. Lectures are not definitely necessary to understand the knowledge. Knowledge of the teachers themselves is however very useful in understanding the whole picture of the course. The exam did cover the course aims and goals.

4.9 Field research instruction geochemistry

Overview

Period	4	Course code	GEO4-1431
Timeslot	Second half	Mean rating last year	-
Teacher	Dh. T. Behrends	Mean workload last year	-
Contact	AW W136 t.behrends@uu.nl	Success rate last year	-

No entry requirements and the course is also not an entry requirement for another course.

Acquired knowledge and skills
In the course you will become familiar with key processes controlling nutrient dynamics (mainly phosphate, ammonium and silicic acid) in aquatic environments (river and estuary). You will design an incubation experiment in the lab and will collect samples in the field which will be analysed in the lab.

Knowledge: Basic knowledge of geochemical processes and aquatic chemistry. Some lab experience is handy but not necessary.

Assessment, structure and work load
At the beginning of the fourth period (so during the course in the first part of the fourth period) groups of students will be made where each group has his own topic (sediment, estuary and river). With your group you will give a presentation about the articles that are written previous year. Further will each student prepare a presentation (max. 30 minutes) about a given topic, which accounts for 30% of the grade. Each week there will be a meeting of 1 hour to discuss how the preparations are going.

The field work starts in Utrecht with a week of preparation. In this week all the presentations will be presented and lectures will be followed. Also the different chemical analysis that will be used during the fieldwork will be practiced in the lab.

The field campaign (two weeks) is (with enough participants) in the Bay of Brest (France). The transport will be done with busses (driven by the students), the accommodations are apartments. During the fieldwork campaign, water samples from rivers, estuaries, and marine locations are collected and analyzed. Additionally, sediment cores will be taken and analyzed. Back in Utrecht you have two weeks to make a report with your group which accounts for 50% of the grade. The other 20% is for your performance in the field.

Experiences
The preparation in the weeks before the course were not very useful. Because you're busy with the other course so not much can be done for this course. The first week in Utrecht was useful but more supervision would be nice. During the field campaign we have done many different things which was very nice. Prepare for long days of work (12 hours a day).

Floor's master track: Environmental geochemistry

Since this track can be found in the masters Earth, Life and Climate as well in Earth Surface and Water it could be thought that a hydrological background is preferred. I think that a background in hydrology certainly has an advantage but is absolutely not necessary. I did not follow any hydrological courses in my bachelor and I did not find any problems following this track.

The courses that I have followed are Aquatic and environmental geochemistry, Principles of groundwater flow, Kinetic processes, Hydrogeological transport phenomena, Reactive transport, Quantitative Water Management, Environmental hydrogeology and Field research instruction Geochemistry. The courses Aquatic and environmental geochemistry and Kinetic processes are the chemistry courses of this track and I think a pre for this master track.

You should be aware of the fact that the course Principles of groundwater flow is an entry requirement for the courses Hydrogeological transport phenomena and Environmental hydrogeology. Hydrogeological transport phenomena is also an entry requirement for the course Environmental hydrogeology. So if you are interested in the hydrological part make sure you have followed the courses Principles of groundwater flow and Hydrogeological transport phenomena. So in the first period I would recommend to take microbes and biogeochemistry course as a third course.

Looking back, I would not have chosen the courses Quantitative Water Management and Environmental hydrogeology. Quantitative Water Management has the level of a first year bachelor course. I think the course Mineral and isotope tracers of Earth processes is a better choice. In the course Environmental hydrogeology there is a lot of repetition of the courses Principles of groundwater flow and Hydrological transport phenomena. Instead of Environmental hydrogeology I would choose the course Organic geochemistry.

5. M-Profile: GEO-Resources

The M-profile Geo-Resources is chosen next to a track. It is open to students of all Master's programmes Earth Sciences of the Utrecht University, but fits best to the programme Earth Structure and Dynamics. To fulfill the track and M-profile requirements, students have to have at least 30 ECTS

of course modules of the chosen track, of which 15 ECTS from the top box, and at least 30 ECTS from the profile-related courses.

GEO-Resources (former Exploration Geology)
Reflection Seismics & Petroleum systems
Geology and Petroleum Geology of the North Sea
Earth Resources
Sustainable and Unconventional Geo-resources
Subsurface Evaluation for Hydrocarbon Exploration and Development (on invitation only)
Free choice

4.1 Reflection seismics & petroleum systems

Overview

Period	1	Course code	GEO4-1441
Timeslot	D	Mean rating last year	
Teacher	Dr. L.C. Matenco	Mean workload last year	
Contact	L.C.Matenco@uu.nl	Success rate last year	

This course is not yet evaluated by us (if you want to help, please send an email to tertius@uavonline.nl).

4.2 Geology and petroleum geology of the North Sea

Overview

Period	2	Course code	GEO4-1517A
Timeslot	C	Mean rating last year	7.8
Teacher	J. de Jager	Mean workload last year	
Contact	j.dejager1@uu.nl	Success rate last year	

Acquired knowledge and skills
The main focus of this course is understanding the complete petroleum system of the North-Sea and hence its evolution through time. This knowledge can obviously be applied to other basins. A variety of subjects will be discussed, ranging from basin formation and source-rock deposition to the implications of overpressures in formation fluids.

Assessment and work-load
Although the subject is not particularly difficult itself there are a lot of long lectures to be followed. Half of the course will be at the VU Amsterdam, and the other half in Utrecht. Jan de Jager will provide the bulk of the lectures but numerous other lecturers from for example TNO and NAM will be lecturing. Overall this is not a very difficult course but there is a lot of material to prepare for the final exam. The course also includes a small field trip to the Wessex basin of Southern England in which the evolution of a petroleum system can be seen in the field.

Experiences
A lot is learned about petroleum geology and the Dutch geology in general, which is very interesting as well. One of the downsides of the course is that it significantly overlaps with other petroleum

courses. Another downside is that the subjects are relatively easy and offers not many academic skills. The field trip to England is a lot of fun and certainly one of the upsides of the course, especially if the weather is nice.

4.3 Earth resources

Overview

Period	3	Course code	GEO4-1425
Timeslot	B	Mean rating last year	
Teacher	Dr. J.H.P. de Bresser	Mean workload last year	
Contact	J.H.P.debresser@uu.nl	Success rate last year	

This course is not yet evaluated by us (if you want to help, please send an email to tertius@uavonline.nl).

4.4 Sustainable and unconventional Geo-resources

Overview

Period	4	Course code	GEO4-1437
Timeslot		Mean rating last year	
Teacher	Dr. L.C. Matenco	Mean workload last year	
Contact	L.C.Matenco@uu.nl	Success rate last year	

This course is not yet evaluated by us (if you want to help, please send an email to tertius@uavonline.nl).

4.5 Subsurface evaluation for hydrocarbon exploration and development

Overview

Period		Course code	
Timeslot		Mean rating last year	
Teacher		Mean workload last year	
Contact		Success rate last year	

This course is not yet evaluated by us (if you want to help, please send an email to tertius@uavonline.nl).

6. M-Profile: Earth and sustainability

The M-profile Earth and sustainability is chosen next to a track. It is open to students of all Master's programmes Earth Sciences of the Utrecht University. To fulfill the track and M-profile requirements, students have to have at least 30 ECTS of course modules of the chosen track, of which 15 ECTS from the top box, and at least 30 ECTS from the profile-related courses.

Earth and Sustainability
Introduction to the Energy and Resource System
Themes in Global Change and Ecosystems
Sustainable Energy Supply & Solutions
Ecosystem Modelling
Energy & Resource Efficiency
Fossil Resources * (**not** for Earth Sciences students)
Energy Policy and Transitions
Climate Systems and Adaptation
Environmental Ethics and Sustainable Development
Development Themes

Courses of this track are not evaluated by us yet.