Alternative course guide

Earth Structure and Dynamics

Last updated: 14-11-2014

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 three tracks of Earth Structure and Dynamics 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.

It is very common for a master student to choose a course which is not at all in the box of his/her track. We invite you to literally think 'outside the track box' and to take a look at courses in other tracks and even programs. In some cases it is even possible to completely design your own study path if you can give good arguments to your tutor and the exam committee for your choices.

Tutor van Earth Structure and Dynamics: Chris Spiers (c.j.spiers@uu.nl).

Contents

1. Basins, orogens and the crust-lithosphere system

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

Track: Basins, orogens and the crust-lithosphere systen
Structure and composition of the earth's interior Dynamics of basins and orogens Tectonophysics Dynamics of the Earth's mantle
Dynamics of sedimentary systems Applied geophysics Magmatic processes Paleomagnetism Structural analysis of deformed rocks Field research instruction geology

1.1 Structure and composition of the earth's interior

Overview

Period	1	Course code	GEO4-1401
Timeslot	A	Mean rating last year	7.6
Teacher	Prof. Dr. J.A. Trampert	Mean workload last year	
Contact	J.A.Trampert@uu.nl	Success rate last year	75%

Acquired knowledge and skills

You will learn the main ideas on the composition and structure of the Earth's interior and on what facts/theories these are based. You will also discover the different perspective of a geochemist and a geophysicist and get acquainted with the approach in modeling chemical and geophysical constraints of the Earth's Interior. You will work with an already existing program and investigate how different parameters (temperature, pressure, chemical composition) affect the model. By figuring this out yourself you get a very good basic understanding why scientists nowadays believe that the geophysical and chemical constraints of the earth's interior are balanced and where these ideas are based on. Moreover you learn how to review literature with a very critical attitude, although you are not an expert on the topic.

This course illustrates very well what is scientific geophysics and teaches you how to gain a critical attitude towards scientific papers in general. This could be also interesting for other tracks than *Basins, orogens and the crust-lithosphere system.*

Assessment, structure and work load

The course contains introduction lectures about physical, mathematical and chemical principles of the earth's interior, modeling exercises (25%), a presentation of an in-depth paper (25%) and a final exam (50%). The modeling and presentation occurs in a team of two. The presentation includes a discussion in class about the quality of the paper. For the exam you have to study all the papers discussed and know all the main findings/arguments. This is a lot of work, however you are also expected to read the papers before they are presented, so you can participate in the discussion and thus again this work is not focused just before the exams but spread over the entire course. Overall, the workload is balanced if you keep up with everything.

Experiences
Teaching from Trampert is really good, especially on the critical attitude towards scientific research. He is also able to explain the basic ideas of very complex methods in geophysics to students who do not study geophysics. Trampert scheduled a meeting with everybody outside lecture hours to make sure that everybody understood their paper correctly. After the final exam the grades were available within a week.

1.2 Dynamics of basins and orogens

Overview

Period	2	Course code	GEO4-1418
Timeslot	D	Mean rating last year	7.6
Teacher	Dr. P.T. Meijer; dr. L.C. Matenco	Mean workload last year	
Contact	P.Meijer@uu.nl	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 the course of 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
The course consists of weekly lectures and practicals (computer and classroom), and presentation sessions. The practicals, presentation, class participation and final exam graded. 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 (following the track Earth Materials) 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.

1.3 Tectonophysics

Overview

Period	2	Course code	GEO4-1409
Timeslot	B	Mean rating last year	7.6
Teacher	Dr. R. Govers, S.A.P.L. Cloetingh	Mean workload last year	
Contact	R.Govers@uu.nl	Success rate last year	

Acquired knowledge and skills
Knowledge: Geophysical processes on the scale of plates and the lithosphere, analyzed by comparing quantitative models and observations. The first part of the course focuses on the lithosphere and its properties (temperature and heat flow, rheology, slab-pull, lithosphere-asthenosphere coupling), the second part focuses on plate boundary processes (ridge dynamics, subduction zone dynamics, foreland and fore arc basins, fold and thrust belts).

Skills: Modeling using the Fortran programming language, analysis of numerical models and their merits and shortcomings, building and analyzing of analogue models, presenting scientific results in oral and written form. The course description on Osiris is very accurate, although an analogue modeling exercise in the Tec-lab is not mentioned. This course does not fit directly into the Earth Materials track, but might be of interest to those who are interested in (quantitative analysis of) large-scale tectonic processes.

Assessment, structure and work load
The course was well-structured with 2 hours of lecture and 2 hours of practical session per scheduled day and 1 assignment per week. An exception was the Tec-lab practical, which involved no lectures. The final part of the course concerned a literature study, writing an essay and oral presentations. There is no exam for this course, nevertheless the workload is heavy. Students are expected to study a paper before each lecture. The time needed for assignments is variable, but all can be finished within a week. If large problems arise with an assignment, additional time is sometimes provided.

Experiences
The organization of the course and the quality of teaching were really good. The small group leads to a relaxed atmosphere in which all students can participate in discussions. A selection of assignments was graded and feedback was given, others were just checked without much feedback. The Tec-lab practicals need some revision, since the building and running of models takes a long time in which no additional exercise was given.

1.4 Dynamics of the Earth's mantle

Overview

Period	3	Course code	GEO4-1416
Timeslot	B	Mean rating last year	7.2
Teacher	Prof. Dr. W. Spakman	Mean workload last year	11-15
Contact	W.Spakman@uu.nl	Success rate last year	11 out of 12

The mean rating, workload and success rate date from the year 2012/2013

Acquired knowledge and skills
The course is a mixture between lectures with applications of numerical modeling in situations that link with topics currently in the news, and lectures that discuss the continuum mechanics background. The practicals evolve around a reader with explanatory texts and assignments. The assignments are all derivations of principles and formulas in continuum mechanics. A first experience with modeling is gained. The program used is already written and no programming is involved. Images of onset of subduction are made for varying parameters.

Assessment, structure and work load
There are no graded tests or deadlines before the end of the mathematical part of the course. Keeping on schedule with the reader is your own responsibility, which can be hard if the material does not come natural to you. However, all assignments are discussed in class, which is very useful. This mathematical part is ended with a test that accounts for 50% of the final score. In the end of the course, every student gets a paper assigned. This paper has to be presented to the group including an explanation of the continuum mechanic formulas used as a background for the numerical modeling (Initial conditions, boundary condition, material behavior (Elastic-Viscous-Plastic-Newtonian). The modeling assignment accounts for 30 % and the presentation for 20%.

Experiences

The course contains a lot of mathematics, comparable to the course of continuum mechanics (Bsc), such as indices in Einsteins notation. It starts with the basics with formulas for conservation of mass and evolves from there to more difficult equations. Sometimes it is difficult to see the connection with what the exercise is related to, e.g. mantle flow or propagation of seismic waves and their delay time. Discussing papers in the end where the formulas are actually applied is very nice. Teaching qualities are good and Spakman keeps track of faster or slower students. However, it appears as if he does not always understand which part you find difficult.

1.5 Dynamics of sedimentary systems

Overview

Period	3	Course code	GEO4-1419
Timeslot	D	Mean rating last year	4.8
Teacher	Joris Eggenhuizen en Paul Meijer	Mean workload last year	16-20
Contact		Success rate last year	29 out of 31

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, structure 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.*

1.6 Applied geophysics

Overview

Period	4	Course code	GEO4-1424A
Timeslot	A	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).

1.7 Magmatic processes

Overview

Period	1	Course code	GEO4-1403
Timeslot		Mean rating last year	6.9
Teacher	M.J. van Bergen	Mean workload last year	
Contact		Success rate last year	

Acquired knowledge and skills
Knowledge: Magma evolution from melting to crystallization and quantification in phase diagrams.
Skills: Microscopic magmatic mineral recognition.
The program description on Osiris seems more variable than what I remember of the course. The course fits the track.

Assessment, structure and work load
Lectures, practical sessions and computer practicals. The microscopy practicals had to be handed in on the day itself and were graded. An individual research on a topic of choice had to be written in the last two weeks. The course ended with a final exam, which was relatively difficult, mainly since no original copies of old exams were available for practicing (they have to be handed in too). The course has a peak work load in the last two weeks.

Experiences
The microscopy practicals were very useful and after this course I really understood the phase diagrams. However, I found the course content too abstract and specific. It was not put in a broader framework, eg. larger scale subduction processes or rifting. I received little feedback on the final report and exam, and the teacher was very late with grading them.

1.8 Paleomagnetism

Overview

Period	3	Course code	GEO4-1438
Timeslot	A	Mean rating last year	6.9
Teacher	Dr. M.J. Dekkers; dr. W. Krijgsman; prof. Dr. C.G. Langereis	Mean workload last year	11-15
Contact	W.Krijgsman@uu.nl	Success rate last year	18 van de 20

Acquired knowledge and skills
Knowledge: First encounter with rock magnetism and its 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 a scientific proposal + presenting it (40 %). Class participation is also graded (10%). 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.

1.9 Structural analysis of deformed rocks

Overview

Period	2	Course code	GEO4-1411
Timeslot	C	Mean rating last year	8.1
Teacher	Dr. J.H.P. de Bresser; dr. M.R. Drury; Prof. Dr. C.J. Spiers	Mean workload last year	
Contact	J.H.P.debresser@uu.nl	Success rate last year	16 out of 18

Acquired knowledge and skills
Knowledge: Structure and dynamics (micro-to-large scale) of brittle and ductile deformed rocks (De Bresser, Spiers); meaning of micro-structures in metamorphic terrains (Drury).
Skills: Metamorphic microscopy, making structured observations of deformed structures
The course description on Osiris is excellent. The course fitted in this track (Basins and orogens).

Assessment, structure and work load
The course is very well-structured with every week two lectures, a practical session (computer or classroom; 35 %), a home assignment (15%) and one final exam (50 %). This resulted in a balanced work load. Because of the good structure, you do a lot and learn a lot, without experiencing a high pressure. The final exam was representative for the course content.

Experiences
All teachers were excellent; motivating students, providing structured assignments and being experts in their field. The course is research-oriented and can be useful for the Msc-fieldwork in period 4. You will get plenty of feedback, however in the last evaluation some people noted that the feedback on the last assignments arrived too late.

1.10 Field research instruction 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:

<u>May</u>
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.

<u>June</u>
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.

<u>July & September</u>
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.

2. Physics of the deep Earth and planets

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

Track: Physics of the deep Earth and planets
Global seismology/Theoretical seismology Applied geophysics Dataprocessing and inverse theory Dynamics of the Earth's mantle Computational geophysics
Tectonophysics Structure and composition of the earth's interior Paleomagnetism

2.1 Global seismology/Theoretical seismology

Overview

Period	2	Course code	GEO4-1408
Timeslot	A	Mean rating last year	7.7
Teacher	dr. J.A.M. Paulssen; prof. dr. J.A. Trampert	Mean workload last year	16-20
Contact	j.a.m.paulssen@uu.nl	Success rate last year	6 out of 7

Acquired knowledge and skills

Knowledge: A follow up on the bachelor course seismology with a strong theoretical aim. The physics and mathematics behind the working of seismological waves is discussed, giving insight in how they travel through the earth. The course description on Osiris is adequate. Four lectures are given by Jeannot Trampert. Skills: High level mathematical and physical understanding of how seismic waves travel and deform the earth.

Assessment, structure and work load

The assignments given during the practical sessions had to be handed in for grading during the course. The assignments require a dedication to bite down and figure out every last step of difficult mathematics. The course ended with a final test based on the assignments. If you don't work structurally at home to finish the assignments, you will have a peak load at the end.

Experiences

The lecture skills of both teachers were very good. Mrs Paulssen is very good at explaining things from step one (if asked) and will keep doing that until you understand the material. Feedback on the assignments is given if you discipline yourself and hand them in a minimum of 2 weeks before the course. The assistant was very helpful and was easy to approach outside practical sessions for questions.

2.2 Applied geophysics

Overview

Period	4	Course code	GEO4-1424A
Timeslot	A	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).

2.3 Dataprocessing and inverse theory

Overview

Period	1	Course code	GEO4-1415
Timeslot	B	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).

2.4 Dynamics of the Earth's mantle

Overview

Period	3	Course code	GEO4-1416
Timeslot	B	Mean rating last year	7.2
Teacher	Prof. Dr. W. Spakman	Mean workload last year	11-15
Contact	W.Spakman@uu.nl	Success rate last year	11 out of 12

The mean rating, workload and success rate date from the year 2012/2013

Acquired knowledge and skills
The course is a mixture between lectures with applications of numerical modeling in situations that link with topics currently in the news, and lectures that discuss the continuum mechanics background. The practicals evolve around a reader with explanatory texts and assignments. The assignments are all derivations of principles and formulas in continuum mechanics. A first experience with modeling is gained. The program used is already written and no programming is involved. Images of onset of subduction are made for varying parameters.

Assessment, structure and work load
There are no graded tests or deadlines before the end of the mathematical part of the course. Keeping on schedule with the reader is your own responsibility, which can be hard if the material does not come natural to you. However, all assignments are discussed in class, which is very useful. This mathematical part is ended with a test that accounts for 50% of the final score. In the end of the course, every student gets a paper assigned. This paper has to be presented to the group including an explanation of the continuum mechanic formulas used as a background for the numerical modeling (Initial conditions, boundary condition, material behavior (Elastic-Viscous-Plastic-Newtonian)). The modeling assignment accounts for 30 % and the presentation for 20%.

Experiences
The course contains a lot of mathematics, comparable to the course of continuum mechanics (Bsc), such as indices in Einsteins notation. It starts with the basics with formulas for conservation of mass and evolves from there to more difficult equations. Sometimes it is difficult to see the connection with what the exercise is related to, e.g. mantle flow or propagation of seismic waves and their delay time. Discussing papers in the end where the formulas are actually applied is very nice. Teaching qualities are good and Spakman keeps track of faster or slower students. However, it appears as if he does not always understand which part you find difficult.

2.5 Computational geophysics

Overview

Period	4	Course code	GEO4-1427
Timeslot	D	Mean rating last year	7.8
Teacher	???	Mean workload last year	16-20
Contact	???	Success rate last year	7 out of 13

NOTE: A.P. van den Berg will retire in January and will most likely not teach the course in 2015

Acquired knowledge and skills
Knowledge: A follow up on the bachelor course Geodynamics and master course Mantle dynamics with a strong focus on computer skill. Skills acquired are a thorough understanding of how computational problems are solved, which techniques can be used for various problems and the mathematics behind the solvers. The practicals give room to practice working with a international program as SEPRAN and require computer programming.

Assessment, structure and work load
The structure of the course is that there are lectures of Mr. van de Berg about the lecture notes he provides on the website http://www.geo.uu.nl/~berg/compgeoph//. The lecture notes contain assignments that should be made in order to understand the exam. No feedback is given on the assignments and no answers are provided. However, there is room to ask questions about the assignments in the lectures. Computer labs are to be made in duo's to be handed in during the course as it suits you. There is a midterm test and a final test of the assignments. Mr. van den Berg is a extremely slow grader so if you want to follow this course and finish your master the September after you will have to specifically ask him to grade as fast as possible.

Experiences
The lecture skills of Mr van den Berg are not very good. He basically skims through the lecture notes during the lecture and tells a bit more where he thinks it is necessary. Best advice would be to read the chapter of the lecture notes very thoroughly before his lecture about that chapter to understand more and be able to follow his talk. He is helpful during the computer labs and answers emails at all times of day.

2.6 Tectonophysics

Overview

Period	2	Course code	GEO4-1409
Timeslot	B	Mean rating last year	7.6
Teacher	Dr. R. Govers, S.A.P.L. Cloetingh	Mean workload last year	
Contact	R.Govers@uu.nl	Success rate last year	

Acquired knowledge and skills

Knowledge: geophysical processes on the scale of plates and the lithosphere, analyzed by comparing quantitative models and observations. The first part of the course focuses on the lithosphere and its properties (temperature and heat flow, rheology, slab-pull, lithosphere-astenosphere coupling), the second part focuses on plate boundary processes (ridge dynamics, subduction zone dynamics, foreland and fore arc basins, fold and thrust belts).
Skills: Modeling using the Fortran programming language, analysis of numerical models and their merits and shortcomings, building and analyzing of analogue models, presenting scientific results in oral and written form. The course description on Osiris is very accurate, although an analogue modeling exercise in the Tec-lab is not mentioned. This course does not fit directly into the Earth Materials track, but might be of interest to those who are interested in (quantitative analysis of) large-scale tectonic processes.

Assessment, structure and work load

The course was well-structured with 2 hours of lecture and 2 hours of practical session per scheduled day and 1 assignment per week. An exception was the Tec-lab practical, which involved no lectures. The final part of the course concerned a literature study, writing an essay and oral presentations. There is no exam for this course, nevertheless the workload is heavy. Students are expected to study a paper before each lecture. The time needed for assignments is variable, but all can be finished within a week. If large problems arise with an assignment, additional time is sometimes provided.

Experiences

The organization of the course and the quality of teaching were really good. The small group leads to a relaxed atmosphere in which all students can participate in discussions. A selection of assignments was graded and feedback was given, others were just checked without much feedback. The Tec-lab practicals need some revision, since the building and running of models takes a long time in which no additional exercise was given.

2.7 Structure and composition of the earth's interior

Overview

Period	1	Course code	GEO4-1401
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).

2.8 Paleomagnetism

Overview

Period	3	Course code	GEO4-1438
Timeslot	A	Mean rating last year	76.9
Teacher	M.J. Dekkers; W.	Mean workload last year	11-15

	Krijgsman; C.G. Langereis		
Contact	W.Krijgsman@uu.nl	Success rate last year	18 out of 20

Acquired knowledge and skills
Knowledge: First encounter with rock magnetism and its 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 a scientific proposal + presenting it (40 %). Class participation is also graded (10%). 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.

3. Earth materials

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

Track: Earth materials
Magmatic processes Mechanisms of deformation and transport in rock Structural analysis of deformed rocks Mineral and isotope tracers of Earth processes Advanced structural-metamorphic petrology and mineralogy
Paleomagnetism Kinetic Processes Field research instruction geology

3.1 Karin's Master Track: Earth Materials

"I picked Magmatic processes, SADR and AMP&M form the top box, Paleomagnetism and Field research from the additional course modules and Natural Hazards and Risk Assessment outside the track. The remaining 67.5 points I filled up with my MSc Research and a Guided Research. Looking back, I would not have chosen Magmatic Processes, since it did not interest me and I found the teaching weak. I would have liked to take Dynamics of Sedimentary Systems (not in track), since it would have helped me during the Field research, and also one course concerning Exploration Geology, to gain at least the basic knowledge . However, such a broad course package would not have matched the requirements of the Earth Materials tracks…"

3.2 Magmatic processes

Overview

Period	1	Course code	GEO4-1403
Timeslot	C	Mean rating last year	6.9
Teacher	Dr. M.J. van Bergen	Mean workload last year	
Contact	M.J.vanbergen@uu.nl	Success rate last year	

Acquired knowledge and skills

Knowledge: magma evolution from melting to crystallization and quantification in phase diagrams
Skills: microscopic magmatic mineral recognition
The program description on Osiris seems more variable than what I remember of the course. The course fits the track.

Assessment, structure and work load

Lectures, practical sessions and computer practicals. The microscopy practicals had to be handed in on the day itself and were graded. An individual research on a topic of choice had to be written in the last two weeks. The course ended with a final exam, which was relatively difficult, mainly since no original copies of old exams were available for practicing (they have to be handed in too). The course has a peak work load in the last two weeks.

Experiences
The microscopy practicals were very useful and after this course I really understood the phase diagrams. However, I found the course content too abstract and specific. It was not put in a broader framework, eg. larger scale subduction processes or rifting. I received little feedback on the final report and exam, and the teacher was very late with grading them.

3.3 Mechanisms of deformation and transport in rock

Overview

Period	3	Course code	GEO4-1410
Timeslot	D	Mean rating last year	7.8
Teacher	C.J. Peach; C.J. Spiers	Mean workload last year	11-15
Contact	C.J.Spiers@uu.nl	Success rate last year	35 out of 37

Acquired knowledge and skills
The course has a lot of overlap of the SPEM course and the rheology part of the continuum mechanics and rheology course of the 3rd year of the bachelor. The first part (Peach) of the course focuses on the behavior of fluids in rocks. Subjects that are discussed are lithostatic and hydrostatic gradients, the origin of fractures and the permeability of rocks. This subject is mainly approached from the perspective of connectivity of pores and connected systems (percolation systems). The second part (Spiers) focuses more on the viscous or plastic deformation of rocks. Fluid transport and pore fluids are important for processes like grain boundary solution. Different microscale processes of deformation are discussed: e.g. dislocation creep, dislocation climb, grain boundary solution.

Assessment, structure and work load
The course was divided into two parts. Both ended with a test; the part of Peach counts for 37.5 % and the part of Spiers (62.5%). The practicals are not graded, but have to be handed in and need to be satisfactory to get a pass.

Experiences
Sometimes lectures took longer and extended into the practical session. Furthermore breaks were given at irregular moments rather than strictly every 45 minutes. A returning point of criticism is the amount of text on slides on the powerpoint slides by Peach, but this is part of the philosophy that in this way at least all the information is on there and available for study when going through the material for the exam. In order to quantify the importance of various processes, during most practicals a mathematic approach is used to determine rate equations. Most of the practicals can be finished during the practical, however some need to be finished at home and handed in at the next practical session. This is a strict deadline. The work load is not too high.

3.4 Structural analysis of deformed rocks

Overview

Period	2	Course code	GEO4-1411
Timeslot		Mean rating last year	8.1
Teacher	J.H.P. de Bresser; M.R. Drury; C.J. Spiers	Mean workload last year	
Contact		Success rate last year	16 out of 18

Acquired knowledge and skills
Knowledge: structure and dynamics (micro-to-large scale) of brittle and ductile deformed rocks (De Bresser, Spiers); meaning of micro-structures in metamorphic terrains (Drury)

Skills: metamorphic microscopy, making structured observations of deformed structures
The course description on Osiris is excellent and the course fitted in this track.

Assessment, structure and work load
The course is very well-structured with every week two lectures, a practical session (computer or classroom; 35 %), a home assignment (15%) and one final exam (50 %). This resulted in a balanced work load. Because of the good structure, you do a lot and learn a lot, without experiencing a high pressure. The final exam was representative for the course content.

Experiences
All teachers were excellent; motivating students, providing structured assignments and being experts in their field. The course is research-oriented and can be useful for the Msc-fieldwork in period 4. You will get plenty of feedback, however in the last evaluation some people noted that the feedback on the last assignments arrived too late.

3.5 Mineral and isotope tracers of Earth processes

Overview

Period	3	Course code	GEO4-1417
Timeslot	C	Mean rating last year	7.1
Teacher	M.R. Drury	Mean workload last year	11-15
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, structure 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.

3.6 Advanced structural-metamorphic petrology and mineralogy

Overview

Period	1	Course code	GEO4-1435
Timeslot		Mean rating last year	7.1
Teacher	H.L.M. van Roermund	Mean workload last year	
Contact		Success rate last year	

Acquired knowledge and skills
Knowledge: first encounter with high pressure metamorphism, insight in PTt-paths and various laboratory techniques and apparatuses used for studying metamorphic rocks
Skills: mineral recognition, both under the microscope as in hand samples, something that is lacking in the bachelor. The description on Osiris is very adequate. I found this course valuable for my track.

Assessment, structure and work load
Lectures and practical sessions. A large variety of assignments given during practical sessions had to be handed in all together at the end of the course to be graded. The assignments were related to real-life research situations, which made them realistic. The course ended with a final test. If you don't work structurally at home to finish the assignments, you will have a peak load at the end.

Experiences
The information on the slides was structured, but the lecture skills of the teacher were not. However, he is an expert and provides good guidance during practical sessions. Since everything has to be handed in in the end of the course, there is no immediate feedback on the practical assignments, except if you explicitly ask for it of course.

3.7 Paleomagnetism

Overview

Period	3	Course code	GEO4-1438
Timeslot	A	Mean rating last year	6.9
Teacher	M.J. Dekkers; W. Krijgsman; C.G. Langereis	Mean workload last year	11-15
Contact	W.Krijgsman@uu.nl	Success rate last year	18 van de 20

Acquired knowledge and skills
Knowledge: First encounter with rock magnetism and its 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 a scientific proposal + presenting it (40 %). Class participation is also graded (10%). 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.

3.8 Kinetic processes

Overview

Period	2	Course code	GEO4-1426
Timeslot	A	Mean rating last year	6.8
Teacher	Dh. T. Behrends Prof. dr. C.J. Spiers	Mean workload last year	16 h
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 den 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.

3.9 Field research instruction 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.

4. 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	7.3
Teacher	Dr. L.C. Matenco	Mean workload last year	
Contact	L.C.Matenco@uu.nl	Success rate last year	38 out of 38

Acquired knowledge and skills

The main focus of the Reflection Seismics part of this course lies on the understanding of the evolution of a sedimentary basin in terms of tectonic and depositional sequences using reflection seismics and the integration of well logs. The Petroleum System part focusses on the geological concepts that control the occurrence of petroleum resources and how they relate to sedimentary basin evolution. Reflection seismics are also used in this part.

Assessment and work-load

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 to understand 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	6.2
Teacher	Dr. J.H.P. de Bresser	Mean workload last year	
Contact	J.H.P.debresser@uu.nl	Success rate last year	39 out of 39

Acquired knowledge and skills
Understanding the concepts, tools and techniques applied to predict the distribution of various natural resources, including ore deposits, surface resources and hydrocarbons. Developing insight in the relationship between them and the regional evolution. And applying this knowledge and skills to case studies concerning Earth Resources.

Assessment and work-load
The average amount of time spend on this course is between 14-18 hours a week of total time spend. There are several guest speakers, last year from TNO and EAGE, with each an own subject in the field of earth resources. The rest of the lectures will be given by Hans de Bresser.

Experiences
Overall the diversity of the lectures and the expertise of the lecturers is a positive thing about this course, although the subjects could be more differentiated. The lectures are too much about petroleum systems while most students who follow the M-profile have had several courses where certain of these topics have already been treated. The assignments are of a good level, but they do not always connect to the given lectures. The non-petroleum subjects are very interesting and broaden the view on resources on the earth.

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).

5. 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 yet evaluated by us (if you want to help, please send an email to tertius@uavonline.nl).