Welcome to Oxford, or welcome back to Oxford!

This handbook is provided for students on the BA in Geology and MEarthSc in Earth Sciences for the academic year 2019-20. Whether you are arriving for the first time, or returning for another year, you should find that it contains the key information that you need to navigate your way around the Earth Sciences degree course:

- how the course is taught
- course structure
- details of options
- logistics of practical work and fieldwork
- modes of examination and assessment.

It also contains all of the important dates (of teaching terms, course-work submission deadlines, field courses and so on), that you will need to be aware of through the year.

This handbook is only available online. This and other web based resources can be found through the 'undergraduate course' links on the departmental website:

https://www.earth.ox.ac.uk/teaching/undergraduates/course-information/

Please refer to the online version which will be updated as necessary during the year.

If you have any questions regarding the course or the department, please consult this handbook first - it is a mine of information; however, if you can't find the answer to any particular questions you have relating to the course, you should contact your college tutor or the Undergraduate Course Advisor.

It is important to note that this handbook only pertains to this current academic year and a new handbook is issued each academic year: the Earth Sciences course is constantly evolving as staff change and knowledge develops.

Conall MacNiocaill (Chair of Faculty)

Hauke Marquardt (Undergraduate Course Advisor)

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<thead>
<tr>
<th>CHANGES TO THE HANDBOOK SINCE 2018-9 version</th>
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<tr>
<td>1. General update and overhaul.</td>
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<tr>
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<tr>
<td>1. Natural Resources course outline updated on p53.</td>
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<tr>
<td>2. Hauke Marquardt's email address corrected on p97.</td>
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<tr>
<td>1. Natural Resources - shelf markers added to reading list in course outline updated on p53.</td>
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<td>2. 2nd year examination details updated for Paper 1 on p78.</td>
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<tr>
<td>1. Alternative travel arrangements sections added to each year under Field Courses.</td>
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The Examination Regulations relating to this course are available at:

http://www.admin.ox.ac.uk/examregs/

If there is a conflict between information in this handbook and the Examination Regulations then you should follow the Examination Regulations. If you have any concerns please contact:

Emma.Brown@earth.ox.ac.uk

The information in this handbook is accurate as at 2 October 2019. However it may be necessary for changes to be made in certain circumstances, as explained at:

www.ox.ac.uk/coursechanges

If such changes are made the department will publish a new version of this handbook together with a list of the changes and students will be informed.

How to use this handbook

At the beginning of this handbook, you can find general information, organised alphabetically, relating to all undergraduate students in 2019-20. You will then find separate sections for 1st, 2nd 3rd and 4th years, including course details and other important information. At the beginning of each of these sections is a table of important dates - please put these dates in your diary now. At the end of the handbook are the appendices, relevant to all students.

Other sources of information

1. Examination Regulations: These can be accessed online at:
http://www.admin.ox.ac.uk/examregs/

2. Online Handbook: This can be accessed on the departmental website here:
https://www.earth.ox.ac.uk/teaching/undergraduates/course-information/

   and on WebLearn here:
https://weblearn.ox.ac.uk/portal/hierarchy/mpls/earth/ugrad/page/course_handbook

3. Lecture List:
http://wise-tt.com/wtt_ou_earth/

4. University Student Handbook: This contains essential information for students, and can be found here:
http://www.proctors.ox.ac.uk/handbook/handbook/

5. Health and Welfare: The University website has a general guide to student health and welfare issues
https://www.ox.ac.uk/students/welfare?wssl=1
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Here is the essential information about Earth Sciences.
This is information for 2019-20 only.

Accreditation

The undergraduate courses are accredited by the Geological Society of London.

Academic Administration Office

This is the office that looks after the undergraduate course and all related matters. It is located in room 10.33 on the ground floor, and has core hours of 8.00am-4.00pm on Monday to Thursday, and 8.00am-3.00pm on Friday. It is closed to visitors 12.00-4.00pm on Tuesdays and Thursdays.

Handing in to the Academic Administration Office

Periodically you will be asked to hand in important items, such as examination material, to this office. If there is nobody in the office, you may hand such material in to Reception staff or leave it in Emma Brown’s pigeonhole (number 62) during office hours. Out of office hours, you may leave it in the white “out of hours” box behind Reception.

If you leave anything important with other staff, in the pigeonhole, or in the out of hours box behind reception, please email Emma.Brown@earth.ox.ac.uk and Claire.Rylatt@earth.ox.ac.uk who will acknowledge safe receipt.

Aims and Objectives of the Department

1. To provide students with a course of the highest academic quality in a challenging but supportive learning environment.

2. To provide students with a broad, balanced knowledge of Earth Sciences.

3. To develop transferable skills related to problem solving, communication, practical techniques and computing.

Building

The Department moved to the current building in September 2010, enjoying world-class teaching and research facilities. The formal teaching facilities (labs, lecture rooms and library) are all located on the
ground floor, connected by the atrium and the undergraduate common area. Tutorials take place either in academic offices, or in meeting rooms on L2 or 04.

Access to the building out of hours is controlled by your university swipe cards, with entry through the door next to the rotating door at the front of the building, or through the bike shed at the back of the building.

### Careers Advice

The University Careers Service is available for advice and guidance right from the very start of your course. They can advise you on how and where to gain relevant work experience and internships outside of term time, as well as providing mentoring opportunities, CV workshops and advice on graduate careers. You can sign up via their website: [http://www.careers.ox.ac.uk/](http://www.careers.ox.ac.uk/) or visit their office at 56 Banbury Road. GeolSoc also organise one-to-one sessions with our dedicated Careers Advisor in the Department, and a geoscience careers fair in Michaelmas Term.

Our alumni - those who have graduated before you - may also be a valuable resource: Earth Sciences alumni are forging careers in a wide range of industries and roles where the skills learned during the undergraduate course can be applied - as well as a few who are putting those skills to good use in entirely unrelated fields.

Alumni frequently visit the Department to advise students and share their experience of life beyond University - whether as part of a recruitment event or in smaller, face-to-face sessions. Many of you will find internships through alumni connections. Department alumni are also members of a dedicated Linkedin group, which you can join to start your career networking well before Finals: [https://www.linkedin.com/groups/3379392](https://www.linkedin.com/groups/3379392).

Undergraduate contributions to the annual alumni magazine are particularly welcome, as are volunteers for alumni events.

If you have any questions, or would like to contact one of our alumni for careers advice, please don't hesitate to contact the External Relations Officer: [alumni@earth.ox.ac.uk](mailto:alumni@earth.ox.ac.uk).

### Communication

Please ensure you regularly check your departmental email address, as this is the primary form of communication used to send students important information.

Staff have pigeonholes in the corridor by the admin offices on the ground floor of the building.

Email addresses, telephone numbers and college affiliations are given in Appendix 4 at the back of this booklet. Notices concerning examinations, field courses etc. are posted on the notice boards in the atrium.

### Disability Contact

The department has three Disability Contacts.

The lead contact is the Departmental Administrator, Ian Wright (room 10.31, ext. 72007, [Ian.Wright@earth.ox.ac.uk](mailto:Ian.Wright@earth.ox.ac.uk)).

For specific building related matters, please contact the Building Manager, Ashleigh Hewson (room 10.32, ext. 72054, [Ashleigh.Hewson@earth.ox.ac.uk](mailto:Ashleigh.Hewson@earth.ox.ac.uk)).

For specific academic related matters, please contact the Academic Administrator, Emma Brown (room 10.33, ext. 72043, [Emma.Brown@earth.ox.ac.uk](mailto:Emma.Brown@earth.ox.ac.uk)).
Feedback and Consultation

### Feedback from students

Each term feedback questionnaires are distributed via WebLearn. You can help us improve the course by commenting (anonymously) on those aspects of the teaching you found particularly helpful or areas in which you see scope for change. These comments and questionnaires are read by teaching staff and discussed by the Joint Consultative Committee (Undergraduate) [JCC(U)] and the Teaching Committee. Students are encouraged to pass comments and suggestions for improvements to the JCC(U) at any time.

The feedback questionnaires are very important and we strongly encourage you to complete them when requested. They are your opportunity to have your say about the modules on your course. Lecturers value hearing your views. The feedback results will also be included in various internal and external reports and reviews, and are used to assess the Department and University.

### Feedback to students

Feedback is provided in many different ways, and is designed to guide students to achieve the levels of understanding described in the exam descriptors and learn how to pursue independent learning, even when explicit numerical values are not assigned to verbal or written answers. Students are provided a wide range of both formal and informal feedback in tutorials and in discussions with instructors in classes, practicals, and on field courses.

In 1st and 2nd year, students take “collections” at the start of Hilary Term. These are papers sat under conditions similar to those of formal examinations. They are designed to provide feedback to students about exam performance and advice on how to prepare for the formal examinations in Trinity Term.

Work completed for practicals or fieldwork exercises may be assigned a mark. These marks do not aggregate to your degree result, but you should treat them as important indicators of the quality of your work. In addition, tutorial work will also commonly be assessed and your college will take a keen interest in the standards you achieve. Again, these marks do not contribute to your degree classification, but they do provide valuable feedback to you on your understanding of the material of the course.

### Geolsoc (OUGS)

The University Geological Society organizes lectures, field excursions and social events throughout the year. Through attending these activities you will not only get to know your fellow students much better, but will also benefit academically. It currently costs £30 for life membership.

### Green Impact

Since the scheme was launched we have been awarded Bronze, Silver, and in 2016 we achieved a Gold award for the building and the laboratories. This was achieved by commitment from all members of the department in various ways, for example, our efforts towards reducing waste, recycling, and other initiatives for saving energy and reducing our carbon footprints. In 2019 the department formed a new team to be the department’s ambassadors for Green Impact and they will be working with everyone in the department to reduce waste and our carbon footprint. If you would like further information regarding the Green Impact Initiative then contact the Building Technician (cornelius.vermaak@earth.ox.ac.uk).

### Libraries

Students can use at least three libraries to access Earth Sciences resources: the Departmental Library and the Radcliffe Science Library (RSL), as well as their own College Library. Books can be borrowed from the Departmental and College Libraries; the Radcliffe Science Library is mainly for reference only but some undergraduate text books can be borrowed. The Departmental Library takes numerous journals and more extensive collections are available via the RSL and electronically.

The Departmental Library, as well as housing books and journals, contains maps, memoirs of geological surveys from around the world, and a large collection of reprints that are available for borrowing. Computer terminals give access to on-line bibliographic services. (See Appendix 6 for more information).
**Lockers**

Lockers are available for undergraduate students in the atrium area. Padlocks are available at Reception for a £5 deposit or you can provide your own padlock. Items left in a locker are stored at your own risk.

Please use a locker, rather than leaving possessions in the atrium, as the atrium is the first impression visitors have of the Department. The Building Manager’s team will do regular sweeps of the atrium area and remove any items left there.

**Outdoor Clothing and Field Equipment**

Throughout your course, your fieldwork will take you to a variety of terrain and weather conditions; it is therefore essential that you have suitable outdoor clothing for all eventualities. Relatively inexpensive good quality clothing can be purchased from specialist outdoor retailers who can also provide useful advice e.g. Cotswold Outdoors, Blacks, GO Outdoors or an independent shop, ideally visiting in person to check fit. NB Oxford does not have a good selection of outdoor retailers, with only GO Outdoors (on the outskirts), although there is a Cotswolds in Bicester, 10 miles away. The department benefits from a 15% discount with Cotswolds ([www.cotswoldoutdoor.com](http://www.cotswoldoutdoor.com)) which can be utilized either on-line or in person at any of their stores; the code is available in the appendices and must be used in conjunction with a University of Oxford ID card.

As first years proceed directly into the field on the Saturday of Nought Week, following induction at the department, students should ensure that they have the following on arrival:

- Waterproof jacket and trousers
- Suitable clothing (using layering principles - it is important to be able to add or take away layers as climatic conditions change). Cotton clothing is not ideal, better to have wicking synthetic fabrics or merino. Denim jeans are not suitable for fieldwork
- Stout waterproof walking boots, with ankle support (trainers are not suitable), and suitable socks
- Field bag or small rucksack, suitable for keeping items dry and spacious enough to carry spare clothing, notebooks, stationery, water and packed lunch
- Warm hat, scarf and gloves
- Sun screen and sun hat
- Sunglasses
- Water bottle
- Small personal first aid kit

The following items will be provided by the department and issued to you on arrival:

- Hard hat
- Safety goggles
- Fluorescent safety vest
- Folding 2m rule
- Compass clinometer
- Geolens
- Field notebook
- Mapping pen
- Estwing E322p pick
- Tick twister
- Water bottle

**Pandemics**

The department (and the wider University) are used to responding quickly to events which might have a significant impact on the provision of teaching, or the smooth running of the examinations. In previous years, for example, we had to respond to the flu pandemic, the travel disruption which followed the Icelandic eruption, and a medicaine during the Greek field course.

The department will notify you via email of any department-specific information or developments.
Printing

Undergraduate printing is sent by default to the Uniflow printer in the undergraduate Computing Laboratory ("Uniflow printer on uniflow-server"), but students may also send printing the the printer/photocopier by Reception ("Department Colour Printer on coreadmin").

Printing costs 5p per sheet for black and white or 10p for colour. Initial printer credit costs £5, payable via the Finance Office in room 10.28 behind reception. Top-up payments can be made as needed. Check your printer balance on the PCs in the Computer Lab: once you have logged in, hover over the £-sign on the task bar.

On leaving the Department, students should see the accounts team to receive a refund if they have not used all their credit.

At the start of the academic year 4th year students who do not have access to a research network and printing will be allocated £20 printing credit for the year. Please notify May Chung (may.chung@earth.ox.ac.uk) if you do not have access to a research group printer.

Prior to the start of Hilary Term, 3rd year students will be granted £10 printing credit to print out their mapping report. They are also allowed to print up to six copies of the map. If any student experiences issues and finds six is not enough, they should flag this with the department’s IT Section (helpdesk@earth.ox.ac.uk) as soon as possible. Otherwise students will be charged for anything over six copies.

In the interests of economy and the environment please print double-sided or, better, use a USB Flash Pen Drive instead of printing at all.

Prizes for Outstanding Academic Work

In recognition of outstanding academic achievement the following prizes are awarded at the Finals Party on the Friday of 9th Week:

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<tr>
<th>Name of prize</th>
<th>Awarded For</th>
<th>Amount</th>
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<tbody>
<tr>
<td>ISC Prize</td>
<td>Best performance in 1st year Mathematics &amp; Geophysics</td>
<td>£200</td>
</tr>
<tr>
<td>BP 2nd Year Prize</td>
<td>Best performance in 2nd year</td>
<td>£250</td>
</tr>
<tr>
<td>Palaeontological Association Prize</td>
<td>Best 3rd or 4th year performance in Palaeontology</td>
<td>2 years free membership</td>
</tr>
<tr>
<td>Mineralogical Association Prize</td>
<td>Best 3rd year performance in Mineralogy</td>
<td>2 years free membership and free journal subscription</td>
</tr>
<tr>
<td>Keith Cox Prize</td>
<td>Best 2nd year mapping exercise in Assynt</td>
<td>£200</td>
</tr>
<tr>
<td>Gibbs Prize</td>
<td>Best FHS mapping report</td>
<td>£400</td>
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<tr>
<td>Shell Prize</td>
<td>Best 3rd year performance in geochemistry</td>
<td>£700</td>
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<tr>
<td>AWE Prize in Geophysics</td>
<td>Best 3rd year performance in geophysics</td>
<td>£300</td>
</tr>
<tr>
<td>Burdett-Coutts Prize</td>
<td>Best overall 3rd year performance in FHS</td>
<td>£1000</td>
</tr>
<tr>
<td>British Geophysical Association</td>
<td>Best 3rd year Geophysics essay</td>
<td>£100</td>
</tr>
<tr>
<td>MOAP Prize</td>
<td>Outstanding 4th year project on climate</td>
<td>£100</td>
</tr>
<tr>
<td>Schlumberger Prize for Best Performance in Geophysics</td>
<td>Best 4th year performance in Geophysics</td>
<td>£600</td>
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<tr>
<td>BP Prize</td>
<td>Best 4th year project</td>
<td>£750</td>
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<tr>
<td>Shell Prize</td>
<td>Best overall performance in 4th year FHS</td>
<td>£700</td>
</tr>
<tr>
<td>British Geological Association Prize</td>
<td>Best 3rd or 4th year geophysics essay or project</td>
<td>£100</td>
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**Safety**

For reference, our detailed Statement of Safety is available at:

https://weblearn.ox.ac.uk/access/content/group/earth/Safety%20Policy.pdf

(Single Sign On required to access).

*Note that all planned field and laboratory activities should be discussed in detail with the appropriate academic and technical staff in order to define specific safety procedures.* This should include proper handling of all equipment, instrumentation and chemicals.

**Safety in the Field**

Fieldwork as part of the Earth Sciences degree involves an element of risk. Training in identifying these risks and the safety procedures required to minimise them form an integral part of the course. The department takes the safety aspects of fieldwork very seriously and all students are given training in field safety. This training begins in the 1st year with compulsory pre-course safety briefings for all field courses, and this procedure continues in all subsequent years. A safety course and a first aid course are provided to 2nd years to prepare them for their summer mapping projects. Any student found breaching the safety guidelines will be removed from a field course. In addition, complete risk assessments must be carried out for all projects prior to the commencement of any fieldwork.

If students have any health issues that may affect their participation in a field course, they will be asked to provide a letter from their GP confirming that they are fit to participate in the various aspects of the course (a list of specific points for your GP to respond to will be provided). *It is the responsibility of the student to ensure that the field course leader and academic administration staff are aware of their health issues.* The student should ensure they discuss with them how their health issues might affect participation in the field course and any special requirements that need to be addressed, in good time before the field course.

**Safety in the Department**

The Departmental Safety Officer (Buildings/Facilities/Services) is Mr Ashleigh Hewson, Tel: 72054; e-mail: Ashleigh.hewson@earth.ox.ac.uk), who should be alerted or consulted on all general safety issues in the department.

**Safety in the Laboratories**

The Departmental Safety Officer (Laboratories) is Mr Steve Wyatt, Tel: 72005; e-mail: steve.wyatt@earth.ox.ac.uk

Principal laboratory safety issues arise for undergraduates in the fourth year of study. Laboratory Managers with responsibility for safety within specific laboratories are listed in the Statement of Safety. All students will receive rigorous safety instructions before they are allowed to carry out laboratory work in connection with their fourth year projects. It is the student’s responsibility to obtain explicit approval before entering any laboratories or beginning any new activities.
### Student Representation

#### Departmental Level - Joint Consultative Committee (Undergraduate) (JCC(U))

Concern about any aspects of the course can be discussed by the Joint Consultative Committee (Undergraduate) of the Earth Sciences Faculty (JCC(U) for short). This committee consists of two student representatives from each year, the Undergraduate Course Advisor and administrative staff. It meets once a term. Students are encouraged to contact a student representative before the meeting if they have issues they would like to be discussed. The issues raised by the students are also brought to the Earth Sciences Faculty and its Teaching Committee for further discussion. A student representative is invited to attend the Faculty meeting each term.

Volunteers for the first year are requested at the Induction meeting and informally. Please contact Emma Brown if you want to become involved.

#### Divisional Level

One JCC(U) rep attends the termly meeting along with others from departments in the Division of Mathematical, Physical and Life Sciences (MPLS). Student members are expected to represent the interests and concerns of students on all undergraduate courses at Divisional level, including joint courses, and will be expected to liaise with appropriate representatives on their departmental Joint Consultative Committee as necessary.

#### University level

Student representatives sitting on the Divisional Board are selected through a process organised by the Oxford University Student Union (OUSU). Details can be found on the OUSU website ([https://www.oxfordsu.org/](https://www.oxfordsu.org/)) along with information about student representation at the University level.

### Student Support and Guidance

Student health and welfare are primarily College responsibilities: tutors and other confidential advisers make up a sympathetic and effective network of support for students. However, you should always feel free to approach any member of the staff in the department that you feel comfortable talking to with any issues or concerns you may have, especially when any incidents occur in the department.

#### Mental Health

Members of Faculty and other Departmental staff care about your wellbeing as well as your academic progress, and are here to help you. If you are struggling in any way, please do not feel you must suffer in silence. However shocking you think the issue may be, or at the other end of the spectrum however frivolous you think it may be, we have probably come across it before or even gone through something similar ourselves. We will take you seriously and do whatever we can to help. If we cannot speak with you there and then, we will make an appointment. If we cannot answer your questions, we will find out. If you do not feel comfortable approaching an office, please email one of us. Please do also look out for each other - in Earth Sciences we are a close community, and none more so than when we are in the field, so do please keep an eye on your colleagues and offer your support and/or help if you think that it is needed.

The Department also has trained Mental Health First Aiders. Currently, the following members of the Department:

- emma.brown@earth.ox.ac.uk
- claire.rylatt@earth.ox.ac.uk
- jan.wright@earth.ox.ac.uk

The University has welfare and counselling services available to help students, and the Student Union has officers working actively to promote student health and welfare. The Proctors’ and Assessor’s Memorandum, which is available from colleges, provides general information on welfare, finance, health and recreation, as well as on student conduct and on the running of University examinations.

The University also has a number of self-help resources online here:
Harassment

The Department and the University do not tolerate harassment in any form. The Department currently has five trained harassment advisers:

- emma.brown@earth.ox.ac.uk
- claire.rylatt@earth.ox.ac.uk
- conall.macnocaill@earth.ox.ac.uk
- helen.johnson@earth.ox.ac.uk
- jamie.long@earth.ox.ac.uk

The role of Harassment Adviser is an informal one, and intended to be a first point of approach for members of the University. Any discussions are treated in strictest confidence, and the complainant stays in control of the process throughout. Formal action will only be taken if the complainant wishes to pursue it.

The University’s Harassment procedures for students are detailed at:

https://edu.admin.ox.ac.uk/harassment-advice

Study Skills

Essay Writing and Numerical Skills

The complex nature of geological information means that essay writing is still a necessary skill for tutorials and examinations. The essay style to be aimed for here should generally be that of a short scientific review article. Non-numerical answers should be provided with a logical structure, introduction, clear headings, labelled figures, and a conclusion. Parts of the course (notably the geophysical options) draw more greatly upon numerical skills. These can be improved through a range of tutorial classes which are available.

Laboratory Work

Skills in handling geological materials are introduced during scheduled practical classes in the Department of Earth Sciences, and during tutorial classes. These materials will include sedimentary, igneous and metamorphic rocks, fossils, structures, geological maps, geophysical and geochemical data. The interpretation of geological maps is considered a core skill, which requires three dimensional thinking. It is expected that students will have basic computer and word-processing skills. Practicals will include work in the Computing Laboratory, while preparation for essays and reports is likely to involve extensive use of library facilities and internet searches.

Fieldwork

There are up to ninety days of field work, including field training and a four to six week Independent (usually Mapping) Project, in the BA and MSc degrees. Careful observations on outcrops in the field notebook should be accompanied by careful and reasonably accurate field sketches which should follow the OASIS rule (orientation, annotation, sketch what you see, interpretation, scale), together with quantitative measurements such as strike and dip. Careful organization, neat writing, and scientific drawing skills should be developed. Remember that the independent mapping project comprises almost 20% of the Part A examination.

Please note that all field courses are provisional, and may have to be re-arranged, altered or cancelled on occasion.

Teaching Laboratories

The Vincent Mineralogical Laboratory

The mineralogy laboratory is the teaching laboratory equipped for mineralogical and petrological study.
One of the principal activities in the laboratory is the study of thin sections of geological materials with the polarising microscope. Each student is encouraged to develop and practise good technique in optical mineralogy and skill in mineral identification. For any problems with your microscope please contact Mr Owen Green (Owen.Green@earth.ox.ac.uk).

The laboratory contains extensive collections of teaching materials, including mineral specimens, hand specimens of rocks, thin sections of rocks and minerals, and crystal models (to illustrate both morphology and internal structure). There is a small reference library of relevant handbooks to aid study and identification. Students are encouraged to use all of the reference materials which are available, but are also asked to take care with delicate samples, and to replace everything after use. Curatorial catalogues have been prepared for the mineralogy collection.

There are facilities for a whole class to view microscope images via a digital camera attached to a polarising microscope, and thin sections can also be viewed at low magnification (valuable for examining microstructures) on the Petroscope, an adapted microfiche reader fitted with polarisers.

**Elementary Laboratory**

Contains collections of fossils (invertebrate fossils and microfossils) and sedimentary rocks used in practicals and maps.

a. **Invertebrate palaeontology:**

There are separate stacks of drawers of material for practicals in the First Year and Second Year. During the Second Year, students are especially recommended to examine the taxonomic drawers relating to bivalves, echinoderms, cephalopods, brachiopods, corals, trilobites and graptolites, in conjunction with provided notes. These fossils are used to illustrate the morphology and diversity of each group covered in the lecture course.

b. **Micropalaeontology:**

Two slide cabinets contain examples of all the major microfossil groups. In the First Year, some use is made of the introductory slides showing radiolarians, diatoms, coccoliths and foraminifera. Special problem assemblages of foraminifera are utilised during practicals in Micropalaeontology in the Third Year. Those taking that course should also examine the teaching set of 20 foraminiferid genera, along with the accompanying notes. There are also extensive collections of Precambrian microfossils.

**Computing Laboratory**

PC workstations are linked to a Windows server.

Every student is given their own account, email facility and personal file space. Printing and scanning facilities are available. Students have access to a standard set of Windows office applications. Other more specialized software is used for teaching, notably mathematical packages (such as Matlab) and software for 3D visualization of geological structures.

**Teaching Modes**

Students will find that their scheduled teaching time breaks down "approximately" as follows for each year:

1st year: Lectures 55%, Practicals 45%

2nd year: Lectures 55%, Practicals 45%

3rd year: Lectures 60%, Practicals 40%

4th year: Project 50%, Seminars 50%

Students are expected to spend at least 40 hours a week studying, including the scheduled teaching, so a good portion of students' time should be spent on private study.
Lectures

Lectures are the principal means by which the course content is delivered to students. Lecturers will use lectures to outline the areas of knowledge they wish the student to be familiar with, to emphasise particularly important concepts, and to motivate students in their learning. Attendance at lectures is crucial. Skipping lectures is always a big mistake, even if you copy lecture notes from someone who has attended, as you may misunderstand the notes of someone who has misunderstood the lecture. Lecturers will often supply reading lists to provide you with the means to review subjects covered in the lecture and to help you study a subject in further detail. Lecturers also make extensive use of handouts: commonly these will include complex diagrams or equations. It is good practice to incorporate this material into your lecture notes either by annotation during the lecture or redrafting afterwards. While many lecturers may use PowerPoint or other electronic media in their lectures, this is not always the most effective way of explaining concepts or delivering information - and you will find that the ways that lecturers run their classes vary significantly from person to person.

We aim to optimize our teaching to students’ needs and to this end students are encouraged to provide feedback on each lecture course. (See example Departmental Questionnaire in Appendices).

Practicals

Practical work supplements and extends the lecture courses. Practical problems allow you to determine whether you really understand the content of the lectures; they also give an opportunity for you to develop key skills (e.g. observational or computational) and familiarize yourself with a range of materials that can only be covered briefly in the time available in lectures. Usually the practical work set should be completed within the hours timetabled for it. However, in some classes you will be expected to complete practical work over a more extended period of time. In some cases, answers to practical exercises may be made available (either at the time, or on WebLearn, or in a later class); but in other practicals you are expected to check your progress with the staff who are running the practical.

In most practicals your work will either be assessed or checked for completeness. Records of completion and the practical work itself may be requested by the examiners, who may use it in helping to define borderlines for degree classes.

Independent Reading

Students are expected to supplement all aspects of formal teaching with independent reading in order to obtain a greater understanding of the curriculum as defined in lectures, practicals and field courses. Students can receive guidance from lecturers and tutors, but should also develop an ability to identify relevant subjects, and to navigate effectively through the literature.

There are increasingly large amounts of information available to you via the internet. Although all literature should be approached critically, particular care should be taken with choosing web sources. Lecturers will usually provide suggestions for further reading in their course handouts, and they may also recommend specific web-based resources to support their courses. In many cases, this information will be accessible through WebLearn.

Fieldwork

Teaching in the field works along different lines than in the lecture theatre or practical laboratory. One of the principal early skills that we want you to develop is an ability to make and record your own accurate observations of field phenomena, and to be able to draw scientifically rigorous conclusions from these observations. Good notebook technique is essential to this endeavour: notebooks are not used in the same manner as for lecture notes but will instead often contain accurate labelled drawings and measurements together with essential information about place and time. You may also find it useful to use a notebook to hypothesize on relationships between different field data. Field course leaders will expect students to show initiative in making their own observations and drawing their own conclusions.

Fieldwork is carried out in all weathers, from intense sunshine to driving rain. You should be properly equipped in terms of clothing and equipment for any weather conditions (essential items include: stout walking boots, rain gear (jacket and trousers), cold weather and sunny weather headgear - see Outdoor Clothing and Field Equipment above).
Hard hats, reflective jackets and goggles will be issued to you by the department. You must have a sturdy note book of at least A5 size, a x10 hand lens, a geological hammer, a compass clinometer. At induction the following will be available: Compass clinometer; hand lens; hard hat; safety goggles; pick/hammer; high visibility vest; field notebook; folding 2 metre rule; tick twister; water bottle; and a mapping pen; in recent years the department has been able to provide these items free of charge to students at their induction, due to generous alumni, BP and Oxford Geological Group donations. Replacement items can be bought from the department at cost price. Please contact Claire Rylatt in room 10.33 if you wish to purchase any items.

To follow University regulations all students must complete a University Travel Insurance form for every field course (see Appendices) for the year.

Assessment of Practical Work and Fieldwork

Practical classes and field work are an essential component of the course in Earth Sciences, and work completed for practical or fieldwork exercises may be assigned a mark. Candidates in Part A may be required to hand in their practical work, field notebooks and any field assignments relating to courses undertaken in their second and third years of study for consultation by the examiners.

Student performance on field courses will be routinely monitored, for example by inspection of field notebooks, and after each field course students will be graded by the field course leader on a four point scale (absent/unsatisfactory/satisfactory/excellent). Examiners may take into account these records of practical and fieldwork, in particular with regard to the attendance record of the candidates, and to any marks awarded for assignments, when awarding classes. Material handed in from practical classes will be taken as evidence of attendance.

For candidates whose attendance record is deemed unsatisfactory (for example, candidates who have failed to complete practical and fieldwork classes without good reason), the examiners have the discretion to reduce the final degree class of the candidate. Examiners may also take into account evidence of excellent performance in field or practical work when drawing up class boundaries.

Tutorials

Tutorials provide a flexible forum for small-group teaching, normally in combinations of between two and four students. Tutorials are the responsibility of the colleges, and will usually be arranged by your college tutors. All of the college tutors in Earth Sciences are also academic staff in the department. Tutorials will be given principally by academic staff (often, but not always by, a college tutor), but they may also be conducted by research staff or senior graduate students. The normal frequency of tutorials is on average two per week in year one (every first year student should expect to receive one tutorial per week in mathematics, and one other tutorial per week covering any aspects of the remainder of the course); and one per week in years two and three. There are no formal tutorials in year four, where instead you will receive close project supervision from one or more project supervisors. Note that tutorial provision is the responsibility of the individual colleges, and so specific provisions should be discussed with college tutors.

The principal purpose of tutorials is to allow exploration of a subject beyond the confines set in lectures or by the examinations, and this can be tailored to the specific interests of the students and the tutor. A tutorial also allows the tutors to monitor closely individual academic progress, and hence provide appropriate advice for further academic development. Work set in tutorials can be in a variety of styles. Common modes are: tutorial essays; hand-specimen interpretation; problem sets; focused map interpretation; oral presentations (individual or team work). Tutors will often be happy to modify the work set to suit a particular tutorial group, especially in the later years of study. While information that is considered an essential part of the curriculum is not provided in tutorials (i.e. there are no essential or required tutorials), tutorials are intended to provide greater understanding of the examined curriculum. All tutors fill-out online assessment forms each term that are provided to each student’s college and which are used to follow up, and give feedback on, student progress. If you have any concerns of any sort about tutorials, or if you feel that you need tutorials on particular topics, you should contact your college tutor.

Computing

Some courses will make use of the computer teaching laboratory. Generally teaching will involve manipulation of a numerical dataset and interactive comparison of observations with models. As a result you should become confident users of spreadsheet software and other data analysis programmes. Additionally lecturers may use the laboratory to develop theoretical concepts.
Seminars

Departmental seminars are held at noon on Fridays during term. These are research seminars in which leading scientists from a variety of disciplines present and discuss work in their particular fields of interest. This is a good opportunity for you to see how science is really done and attendance at these seminars is compulsory for fourth year students. Many third year students will also find these seminars helpful or interesting.

4th year options are partly taught as seminars, with students taking turns to research a topic and deliver a presentation on it to the rest of the class.

Term Dates

- **Michaelmas Term 2019**  Sunday 13 October to Saturday 7 December 2019
- **Hilary Term 2020**  Sunday 19 January to Saturday 14 March 2020
- **Trinity Term 2020**  Sunday 26 April to Saturday 20 June 2020

University Museum of Natural History

The Oxford University Museum of Natural History houses the University's scientific collections of zoological, entomological, palaeontological and mineral specimens, accumulated in the course of the last three centuries. The Museum has a very close historical association with the department, and still has joint staff appointments.

Vacations

The Oxford terms are short and much of the reading that is set during lectures and practicals can only be completed during vacations. This is equally true of Christmas, Easter and Summer vacations, although much of the Easter vacation may also be taken up with field courses. Vacations additionally provide an essential opportunity for you to concentrate on completion of map and research project reports.

Virtual Learning Environment

**WebLearn**

Course information, learning support materials provided by lecturers, and other useful information (including this handbook) are accessible through WebLearn for 2nd, 3rd and 3th year undergraduates, the University’s centralised Virtual Learning Environment (https://weblearn.ox.ac.uk/portal). It can be reached through any web browser, from anywhere, using the same username and password as for your College email.

**Canvas**

Materials for for 1st year undergraduates can be found on Canvas, the University’s new centralised Virtual Learning Environment, which is being phased in from 2019-20 onwards (https://login.canvas.ox.ac.uk/). As with WebLearn, it can be reached through any web browser, from anywhere, using the same username and password as for your College email.

Websites

<p>| University website | <a href="http://www.ox.ac.uk/current_students/index.html">http://www.ox.ac.uk/current_students/index.html</a> |
| Department website | <a href="http://www.earth.ox.ac.uk/">http://www.earth.ox.ac.uk/</a> |</p>
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<td><a href="http://www.lang.ox.ac.uk/">http://www.lang.ox.ac.uk/</a> to begin and improve foreign language skills.</td>
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<tr>
<td>IT Services</td>
<td><a href="http://www.it.ox.ac.uk/">http://www.it.ox.ac.uk/</a> has many useful computing courses.</td>
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**FIRST YEAR COURSE**

### Deadlines

Please note:

1. Some of these dates are based on previous years, and may be subject to change. Every effort will be made to notify students of any changes as soon as possible. In the meantime PLEASE PUT THESE DATES IN YOUR DIARY NOW. You may not receive further reminders about some items.

2. These deadlines relate to departmental business, and you may have other important dates relating to college business.

3. Examination and some field course dates are in italics, as they will be confirmed nearer the time.

4. Deadlines in bold are included in the examination regulations or conventions and you may be penalised by the examiners if you do not meet them. ALL EXAMINATION MATERIAL SHOULD BE HANDED IN TO EMMA BROWN OR THE ADMINISTRATIVE OFFICER IN ROOM 10.33.

### Induction

Undergraduate Induction takes place on the Friday afternoon of 0th week and early Michaelmas Term. The purpose of Induction is to introduce students to departmental life as an undergraduate, and to show them the facilities on offer. Students will receive briefings from the Head of Department and Undergraduate Adviser, and support staff.

### Tutorials

The normal frequency of tutorials in the 1st year is on average two per week in year one (every first year student should expect to receive one tutorial per week in mathematics, and one other tutorial per week covering any aspects of the remainder of the course).
"Collections"

Informal examinations may be taken in the department or in your college. Marks from collections are good indicators of the progress you are making with particular strands of the course: colleges may in some circumstances insist that certain marks are achieved in collections.

Examinations

Please see Appendix 1: Examining Conventions.
### COURSE STRUCTURE

1st year, 2019-20

<table>
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<td>An Introduction to Geological Processes</td>
<td>1 day field course</td>
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<td>SR 12L + 8P</td>
<td>RB</td>
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<td>8L + 16P</td>
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Fieldtrips:
- L=Lecture
- P=Practical
- T=Tutorial
- Pembroke
- Arran
- Local fieldtrips

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Course Synopses and Reading Lists

Books used in each lecture course may be ranked as: Essential (***); Useful (**); Supplementary (*). Numbers in bold type indicate the shelf-mark of each book. There should be a reference copy of each title in the “Confined Cupboard”. Loan copies will also usually be available and will have the same shelf location. (Check the online catalogue - OLIS - for copies in other libraries). It is easy to recall books that are out on loan by emailing the librarian.

Further reading (e.g. research papers) will be provided in lectures.

Details of all courses, including reading lists and lecturers, may be subject to change by individual instructors.

The First Year Course
Earth Sciences students come to Oxford with a range of A-level subject combinations. The first year course is therefore designed to bring all incoming students up to the same level of knowledge in the fundamentals of Geology, as well as in the underpinning disciplines of maths, physics, chemistry, and biology, as applied to Earth Science.

Planet Earth
Prof D Porcelli, Prof T Nissen-Meyer, Prof D Pyle, Prof H Johnson, Prof C MacNiocaill & Prof P Smith

A review of key topics in Earth Sciences, including the principal chemical, physical and biological processes operating on the planet today and through Earth history.

Topics:

- Nucleosynthesis
- Solar system formation
- Moon formation
- Terrestrial planets, meteorites
- Giant planets, comets, asteroids
- Planetary Differentiation
- Bulk Composition of the Earth
- Global calculations: Mass balances, fluxes
- Mixing calculations
- Geological Timescale
- Precambrian
- Early Palaeozoic
- Late Palaeozoic
- Mesozoic
- Paleogene
- Introduction to Seismology
- Elastic properties, wave properties, wave refraction
- Travel-time curves, Earth structure
- Gravity Anomalies
- Post Glacial Recovery
- Isostasy and Geoid
- Continental Drift
- Seafloor spreading and plate tectonics
- Consequences of plate tectonics
- Heat Flow and age of Earth
- Thermal and mechanical structure of plates
- Flow of rocks
- Melting of the Mantle
- Movement, storage and eruption of magma
- Eruption of magma
- Physics of eruption columns
- Global energy balance
- Forces on a rotating planet
- Basic dynamics of the atmosphere and ocean
- Atmospheric general circulation
- UK weather
- Ocean circulation - forcing and large scale features
- Ekman currents in the ocean
- Wind-driven gyres
- Atlantic meridional overturning circulation
- ENSO and tides
- How a Habitable Planet was Built. Background (timeframe, major features).
- Living prokaryote types and the Origins of Life
- The Five Bio-Revolutions. Life Before 2 billion
- From eukaryotes to animals
- Life on Land

Reading:

Planet Earth (Magmatism and Plate Tectonics)
Prof David Pyle

General themes and outcomes
This set of four lectures will provide an overview of current ideas about how the Earth melts, and the nature of the magmas that form in different plate tectonic settings.

Lecture-by-lecture outline

There will be four one-hour lectures that cover the following topics in order:

1. Earth’s interior, and models for melting
2. Melting in different tectonic settings, and the origins of the oceanic crust.
3. Melting and magmatism in subduction zones
4. Storage, evolution and eruption of magmas

Exam descriptor
Multi-part questions, that may require a mixture of short answers (definitions, explanations, diagrams) and longer (short essay) answers.

Reading list

Further suggestions for reading, and links to other relevant resources will be available in the Online Reading list for this course.

Online Reading Lists:
EARTH_MEarthSci_1st year_Planet Earth_MT
http://readinglists.bodleian.ox.ac.uk/lists/6530CCF6-4F26-E986-CDED-2324C10AE337
EARTH_MEarthSci_1st year_Planet Earth_HT
http://readinglists.bodleian.ox.ac.uk/lists/299F603F-C827-5DE8-E1DF-315E0FED2B16
EARTH_MEarthSci_1st year_Planet Earth_TT
http://readinglists.bodleian.ox.ac.uk/lists/FB81C79A-0D13-0D65-DF74-48BDFE129C75

Fundamentals of Geology I

Crystals & Minerals (Michaelmas Term)
Prof C MacNiocaill & Prof D Porcelli

This part of the course consists of a survey of the important mineral groups and their natural occurrences. It begins with an overview of bonding forces in crystals, the packing of individual atoms and molecules within mineral structures, and the thermodynamic controls on mineral composition and structure. The rest
of the course focuses on the systematics of the major mineral groups, incorporating their chemical composition, their crystallographic structures, and where they occur on Earth. Particular emphasis is placed on putting minerals into a geological context; why certain mineral associations occur where they do, both laterally on the surface of the Earth, and vertically down into the crust and the interior of the Earth. Lectures are complemented by practicals where students learn the physical and optical (using petrological microscopes) properties of the common rock-forming minerals, and how to identify them, both in hand specimen and thin-section.

Topics:

- Crystallography and material properties
- Symmetry and miller Indices
- Introduction to optics
- Introduction to silicates
- Orthosilicates, garnets, Al2SiO5
- Sorosilicates and Inosilicates
- Inosilicates
- Cyclosilicates
- Tecosilicates
- Carbonates
- Biominerals
- Binary Phase Diagrams
- Ternary Phase Diagrams
- Igneous Rock Classification
- Magmatic Differentiation
- Introduction to Metamorphic Petrology
- Introduction to Microscopes
- Isotope dating and Isotope evolution of the Earth

Reading:

Online Reading List:
EARTH_MEarthSci_1st year_Fundamentals of Geology I: Crystals and Minerals
http://readinglists.bodleian.ox.ac.uk/lists/744C2B11-C80F-751E-D29E-C36531AE84A5

An introduction to Geological Processes (Hilary Term)
Prof S Robinson

This part of the course provides an introduction to the broad range of processes that operate at Earth’s surface and the sediments that result. Through lectures and practicals the course will provide training in how sediments are classified and described; how features of sedimentary rocks can be used to determine the environment of deposition; and an introduction to how sedimentary rocks and sequences can be used to unravel Earth history through time. The course will also highlight how the principles being described have broader relevance to a range of Earth science issues.

Topics:

- Weathering and erosion
- Sediment composition, textures and classification
- Sedimentary structures
- From sediment to rock
- Lakes and Deserts
- Rivers
- Deltas and Barrier Islands
- Marine environments
- Turbidity flows
- Ocean chemistry (nutrients, CCD, gases, salt)
- Pelagic sediments
- Shallow water carbonates
- Evidence for climate change from the geological record
- Graphic logging

Reading:
Nichols, G. (2009), Sedimentology and Stratigraphy, Wiley-Blackwell, 2nd edition 4A.103A

Online Reading List:
EARTH_MEarthSci_1st year_Fundamentals of Geology I: Geological Processes
http://readinglists.bodleian.ox.ac.uk/lists/9AE4CE93-B6D4-E033-1B4A-EC6BC93F480

Fundamentals of Geology II

Geological maps (Michaelmas Term weeks 1-8, Hilary Term weeks 1-2)
Prof J Cartwright & Prof P Smith

This is a general introduction to the skills of interpreting geological maps and of visualising geological structures in three dimensions. Over the first four weeks we begin by learning, mainly through artificial, simplified maps, how the three-dimensional shapes of rock bodies are represented on geological maps. We learn how to deduce a sequence of geological events, and how to construct vertical cross-sections through the geological structure. In weeks 5 to 8 we practise these skills on published geological maps. The Hilary Term sessions are used to give feedback on the Collection exercise, and to explore further mapping techniques.

There are extensive online resources on WebLearn at https://weblearn.ox.ac.uk/x/gOGU2y

Reading:
These are older books, but the subject doesn't change, and you should find these in libraries. Butler and Bell is strongly recommended, as it covers some of the specific maps and techniques used in the course.


Online Reading List:
EARTH_MEarthSci_1st year_Fundamentals of Geology II: Geological Maps
http://readinglists.bodleian.ox.ac.uk/lists/D34D2FEC-EE20-EC41-CA88-D66F402EB721

Topics:
- Introduction to Maps
- Planar dipping strata
- Faulting and Unconformities
- Strata with variable dips, folds
- The Cheddar Map: folding, a continental unconformity
- The Stirling Map: stratigraphic thicknesses, throw on faults
- The Shrewsbury Map: unconformities
- Kurundi, Central Australia: section across a fold belt
- Collection feedback; structure contours
- The Arran Map: igneous geology, preparation for the field course

Invertebrate Palaeobiology (Hilary Term)
Dr R Anderson
8 Lectures, 6 x 2hr Practicals

The Hilary term component focuses on major aspects of the fossil record and its interpretation and use by geologists.

Course themes:
- Types of fossil
- Fossilisation processes
- The origins of animal diversity
- Ecology of fossil organisms
- Geological time and biostratigraphy
- Evolution
- Macroevolution
- Extinction
- Major invertebrate fossil types, identification and ecology

**Reading:**
Clarkson ENK. 1998. Invertebrate Palaeontology and Evolution. Blackwell 5A.84C

**Online Reading List:**
EARTH_MEarthSci_1st year_Fundamentals of Geology II: Invertebrate Palaeobiology
[http://readinglists.bodleian.ox.ac.uk/lists/957DB23-222E-8D37-0B43-2153AD5BD476](http://readinglists.bodleian.ox.ac.uk/lists/957DB23-222E-8D37-0B43-2153AD5BD476)

**Fundamentals of Geology Field Courses**
These will take place in Trinity Term. Please see [under Field Courses](#) for details.

**Chemistry, Physics & Biology**
Prof T Mather, Prof R Katz, Prof D Porcelli, Prof R Rickaby, Prof H Marquardt & Prof H Bouman

Key basic science skills as applied to Earth Science problems.

**Topics:**
- Atomic theory
- Electrons
- Electron configurations, ionic bonding
- VB, MO, and crystal field theory
- Examples of applications
- Newton's Laws of Motion
- Motion in 1-2D, harmonic motion
- Forces, Energy, Work
- Circular motion, Coriolis Force
- Gravitation
- Mechanics of fluids
- Scaling relations in fluid flow
- Convection in mantle
- Thermodynamics Intro.
- Kinetic theory I- Boltzmann Distr.
- Kinetic theory II- ideal gas law
- Kinetic theory III- diffusion heat
- Thermo I- first law, definitions
- Thermo II-Second law, Carnot cycle
- Thermo III-entropy, adiabatic mantle
- Thermo IV-phase transitions, diagrams
- Diffusion
- Kinetics
- Adsorption
- Equilibria/solubility
- Redox potentials
- Aqueous chem I
- Aqueous chem II
- Organic geochem
- Cell structure
- Cell chemistry
- Membrane structure
- Photosynthesis
General themes and outcomes
The aim is to get the whole class to a similar level of knowledge, slightly above advanced school chemistry, regarding the properties and interactions of the elements. This knowledge underpins future parts of the Earth Sciences course.

Lecture-by-lecture outline (with total number of lectures/practicals)
Each 1-hour lecture is accompanied by a 2-hour problems class. The idea is to cement concepts introduced or revised in the lecture and to allow those students who did not take advanced chemistry at school extra time to ask questions and practice the concepts. The topics covered in each of the 5 blocks of 3 hours are:

5. An introduction to atomic theory (includes atomic structure, molar calculations and problems for classical mechanics when applied to the atomic scale)
6. The behaviour of electrons (includes the quantisation of energy, the wave character of electrons, an introduction to wavefunctions and solving the Schrödinger equation and atomic orbitals)
7. Relating electron configurations to atomic properties and bonding (includes the Aufbau principle, electron configurations of the elements, effective nuclear charge, periodicity and the periodic table, ionic bonding, covalent bonding and the valence shell electron pair repulsion – VSEPR – model for predicting molecular shape)
8. Further consideration of molecular bonding and structure (includes valence bond theory, molecular orbital theory and crystal field theory)
9. Examples of application atomic properties to geosciences problems (includes Goldschmidt’s classifications and ionic properties and melt-mineral partitioning behaviour)

Practicals and techniques learned/used
Specific skills acquired/revised will include:
- Interpreting atomic and mass numbers
- Molar calculations
- Wavelength, energy, frequency calculations
- Predict the shape of simple molecules using VSEPR
- Explain the bonding in simple molecules using valence bond and molecular orbital theories
- Make predictions about trace element melt-mineral partitioning behaviour from ionic properties

Exam descriptor
Multi-part questions with some calculation, some conceptual and some descriptive parts.

Reading:
Classical Mechanics, Michael Cohen. This is a free electronic textbook, available as a PDF at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.226.8094&rep=rep1&type=pdf
You may also be able to obtain it as an iBook. It will be available as part of the course material provided when you are here. We shall not cover all the material in this book, primarily being interested in those aspects of mechanics that apply to geophysics.
Atkins, P., de Paula, J. (2013) Elements of physical chemistry (6th ed.) - 21A.79A
Peter Molnar (2015) A very short introduction to plate tectonics Oxford University Press. 4E.1

N.B. There is a copy of each of these books in the Confined Cupboard and also at least one loan copy is available.

Online Reading List:
EARTH_MEarthSci_1st year_Physics, Chemistry, Biology (PCB)
Mathematics
Professor S Khatiwala, Prof H Johnson & Prof J Hawthorne

Lecture by Lecture Outline

Michaelmas Term
Prof H L Johnson, Prof J Hawthorne
16 Lectures, 8 Tutorials

L1-2: Ordinary differentiation.
L3-5: Partial Differentiation.
L6-8: Integration and its applications.
L9-10: Power series (Taylor, Maclaurin, exp, sin, cos), Binomial Theorem, convergence and limits.
L11-12: First order ordinary differential equations.
L15-16: Stability analysis.

Hilary Term
Prof S Khatiwala
16 Lectures, 8 Tutorials

L1-2: Basics of vectors and matrices.
L3-4: Linear systems of equations (row and column interpretation of linear equations; Gauss elimination; Gauss-Jordan inverse; LU factorization).
L5-6: Where matrices come from (partial differential equations and finite difference approximations; explicit and implicit schemes for numerical solution of differential equations).
L7-9: Vector spaces (definition and examples; the column, row and nullspace of a matrix; rank of a matrix; complete solution to Ax=b; existence and uniqueness of solutions; linear independence and basis).
L10-11: Determinants (cofactor formula; properties of determinants; Laplace's displacement; determinant and invertibility of a matrix; Cramer's rule).
L12-14: Eigenvectors and eigenvalues (geometric interpretation; characteristic polynomial and computing eigenvalues and eigenvectors; diagonalization of a matrix).
L15-16: Applications of eigenvectors (matrix exponentials; solution of linear differential equations; normal mode analysis; linear stability analysis).

General themes and outcomes

Michaelmas Term
Prof H L Johnson, Prof J Hawthorne
Earth Sciences students come to Oxford with a range of A-level subject combinations. The first year maths course is therefore designed to bring all incoming students up the same level of knowledge in the fundamentals of calculus, differential equations, linear algebra and scientific computing as applied to Earth Science.

The normal frequency of maths tutorials in the 1st year is on average one per week.

These topics will be covered in MT

- Ordinary and partial differentiation
- Indefinite and definite integrals
- Power series
- Ordinary differential equations
- Stability analysis

Hilary Term
Prof S Khatiwala
16 Lectures, 8 Tutorials
These topics will be covered in HT

- Matrix algebra
- Solving systems of linear equations
- Matrix inverse; matrix factorizations
- Vector spaces, bases, and dimension
- Determinants
- Eigenvalue problems and diagonalization
- Numerical solution of ordinary and partial differential equations
- Introduction to scientific computing and computer programming in Matlab

Trinity Term
4 revision lectures

Practicals and techniques learned/used

- Formulating and solving problems mathematically
- Formulating a mathematical problem in a manner that can be solved numerical on a computer
- Basic computer science and programming skills

There will be on collection at the start of Hilary Term covering material from Michaelmas Term.

Reading:

Online Reading Lists:
EARTH_MEarthSci_1st year_Mathematics_MT
http://readinglists.bodleian.ox.ac.uk/lists/0F5ACD5B-6F08-70B6-6E45-18959ADADAD5

EARTH_MEarthSci_1st year_Mathematics_HT
http://readinglists.bodleian.ox.ac.uk/lists/6AB1FF77-70D7-061B-6B7D-0CB80F28D994

FIELD COURSES

Health Issues
If students have any health issues that may affect their participation in a field course, they will be asked to provide a letter from their GP confirming that they are fit to participate in the various aspects of the course (a list of specific points for your GP to respond to will be provided). It is the responsibility of the student to ensure that the field course leader and academic administration staff are aware of their health issues. The student should ensure they discuss with them how their health issues might affect participation in the field course and any special requirements that need to be addressed, in good time before the field course.

Alternative Travel Arrangements
We encourage students to travel with the main group as much as is practicable.

Students who do not intend to travel as part of the main group for field courses, must inform the Academic Office as soon as possible. Students must make their own arrangements to and from an agreed location (such as the airport or accommodation), and they must work around the timings for the group, for example, if the course includes a flight, the student must arrive before or at the same time as
the group so as not to cause a delay, and on the return they must depart at the same time or later than
the group.

For courses with flights, students can be reimbursed for their alternative travel arrangements up to the
cost of the flights per person on the group booking, minus any cost that the department may have
already paid and cannot reclaim. An Expenses Claim form must be completed, signed, and submitted to
the Academic Office with original itemised receipts (https://finance.admin.ox.ac.uk/claiming-expenses-
departmental-guidance).

For courses without flights, alternative travel arrangements would be at the student’s own expense as we
would still have the cost of the coach.

Pembrokeshire

This four-day field course takes place over a long weekend at the start of the first term, so as to introduce
students as soon as possible to the techniques of studying geological features in the field. From the
relationships between rocks one can deduce the sequence of events (sedimentation, igneous intrusion,
folding and faulting) and so determine the geological history of the area.

The first day is spent at Marloes Bay, and the second around St David’s, and the third at West Angle Bay
and Tenby. Students learn a range of skills:

- Identifying different types of rock in the field, and deducing what environment they formed in.
- Examining their textural features and structures, and distinguishing those that form at the time of
deposition from those that form later.
- Using the geological compass- clinometer to measure the orientation of rock strata and other
  features.
- Assembling all this information on rock type, environment, structure and sequence of events, to
determine the evolution through geological time of this part of the Earth’s crust.

In the evenings, the day’s observations are discussed and brought into the wider context of the geological
evolution of Wales.

Online Reading List:
EARTH_MEarthSci_1st year_Pembroke Field Trip
http://readinglists.bodleian.ox.ac.uk/lists/159B8631-EC9D-CF66-0FB2-E29E3FCAA9C6

Arran

The island of Arran, in the Firth of Clyde, is a fascinating outdoor laboratory of geology. Its rock record
and landforms reveal most of the geological history of northern Britain from the Late Precambrian to the
present day. It is famous for the astonishing variety of its igneous rocks in lavas, dykes, sills and plutons.
It lies astride the geological boundary between Scotland’s Midland Valley and the metamorphic rocks of the
Caledonian mountain belt in the Scottish Highlands.

Here, students learn the fundamental skills of field geology: observing rocks at all scales, recording and
measuring field data, and the techniques of geological mapping. Mapping is one of an Earth scientist’s most
fundamental skills. It comprises the ability to record and interpret the three-dimensional patterns and
relationships of rock bodies, and to work out the sequence of events that formed them. As part of the
training, students learn:

- to record information in a field notebook: descriptive notes and measurements of thickness,
distance, orientation.
- to make detailed and clearly labelled sketches of features seen in outcrop, with interpretation.
- to log sedimentary successions in continuous outcrop and interpret environments of deposition.
- to record outcropping rock types, measurements and other data on field slips - copies of
topographic base maps taken into the field. On return from the field, students learn to compile
the final version of a geological map from their field slips and recorded data, adding further
interpretation in the form of cross sections and an account of the geological history.

Suggested reading
Local Geology (Prof R Benson & Prof S Robinson)

These sessions in Trinity Term examine geology accessible within a short coach journey from Oxford and the Cotswolds, illustrating topics that are covered in the Earth Surface Processes lectures, and allowing students to practice fundamental field mapping and observational skills introduced in previous field excursions. Dates and finalized destinations will be confirmed during the year and are dependent on access and tides.

Excursion 1 (whole day): This field excursion examines the Corallian limestones formed in the coral reef environments to the east and southwest of Oxford (e.g. at Rock Edge, Headington, Wheatley Quarry, & the Cumnor Ridge) giving practical experience of palaeogeography, palaeobiology and interpreting depositional environments.

Excursion 2 (whole day): Examination of the sediments across the Triassic-Jurassic boundary at Garden Cliff, Westbury-on-Severn, and then the Inferior Oolite Group at Leckhampton Hill, Gloucestershire.

Suggested reading:

Powell, P., (2005), The geology of Oxfordshire, The Dovecote Press, Wimborne - 3C17:49.5
British Museum (2004 & other editions) British Mesozoic Fossils - 5A.42E

Online Reading List:
EARTH_MEarthSci_1st year_Fundamentals of Geology: Local Field Trips
http://readinglists.bodleian.ox.ac.uk/lists/3245E223-CB3B-E346-41B2-0F55C0CF298E
SECOND YEAR COURSE

Deadlines

Please note:

1. Some of these dates are based on previous years, and may be subject to change. Every effort will be made to notify students of any changes as soon as possible. In the meantime PLEASE PUT THESE DATES IN YOUR DIARY NOW. You may not receive further reminders about some items.

2. These deadlines relate to departmental business, and you may have other important dates relating to college business.

3. Examination and some field course dates are in italics, as they will be confirmed nearer the time.

4. Deadlines in bold are included in the examination regulations or conventions and you may be penalised by the examiners if you do not meet them. ALL EXAMINATION MATERIAL SHOULD BE HANDED IN TO EMMA BROWN OR THE ADMINISTRATIVE OFFICER IN ROOM 10.33.

<table>
<thead>
<tr>
<th>TERM</th>
<th>WEEK</th>
<th>DAY</th>
<th>TIME</th>
<th>ITEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michaelmas Term</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Begin to consider mapping area.</td>
</tr>
<tr>
<td></td>
<td>Week -2</td>
<td>Mon 23 - Mon 30 Sep</td>
<td>1.30pm</td>
<td>Dorset field course</td>
</tr>
<tr>
<td>Hilary Term</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Consider mapping area.</td>
</tr>
<tr>
<td></td>
<td>Week 0</td>
<td>N/A</td>
<td>N/A</td>
<td>Collections</td>
</tr>
<tr>
<td></td>
<td>Week 2</td>
<td>N/A</td>
<td>N/A</td>
<td>Risk Assessment Forms for mapping available</td>
</tr>
<tr>
<td></td>
<td>Week 6</td>
<td>N/A</td>
<td>4.00pm</td>
<td>Submit mapping plan to Stuart Robinson.</td>
</tr>
<tr>
<td></td>
<td>Week 8</td>
<td>TBA</td>
<td>TBA</td>
<td>Final approval of mapping area by Mapping Committee</td>
</tr>
<tr>
<td></td>
<td>Week 8</td>
<td>Friday</td>
<td>4.00pm</td>
<td>Submit Risk Assessment Form and insurance form for mapping area to Reception.</td>
</tr>
<tr>
<td>Easter Vacation</td>
<td>N/A</td>
<td>22 April - 1 May TBC</td>
<td>N/A</td>
<td>Assynt field course</td>
</tr>
<tr>
<td>Trinity Term</td>
<td>Week 6</td>
<td>Days TBC</td>
<td>Times TBC</td>
<td>2\textsuperscript{nd} Year examinations</td>
</tr>
<tr>
<td></td>
<td>Week 8</td>
<td>N/A</td>
<td>N/A</td>
<td>Bank details forms for Mapping payments due</td>
</tr>
<tr>
<td></td>
<td>Week 9</td>
<td>Monday</td>
<td>4pm</td>
<td>Deadline for Roger Walling Fund applications</td>
</tr>
<tr>
<td>Long Vacation</td>
<td>N/A</td>
<td>TBC</td>
<td>N/A</td>
<td>Mapping Project fieldwork</td>
</tr>
</tbody>
</table>

Second Year

The second year course will go beyond the introductory level and equip students with a more comprehensive knowledge of Earth Sciences topics as well as develop practical skills in observation and data manipulation.

The course will be subdivided into five principal streams: 1) Deposition and Subsurface Exploration, which includes Sedimentology and Stratigraphy, Geological Maps, and Geophysical Methods in Geology; 2) Earth Deformation and Materials, including Structural Geology, Igneous Processes, and Metamorphic Processes; 3) Palaeobiology & Palaeoenvironments, including Sedimentary Petrology, and The Fossil Record; 4)
Geochemistry, including Carbon Cycle, Stable Isotopes, and Radioisotopes, and; 5) Geodynamics and Tectonics.

Cross-cutting these streams will be enabling courses in quantitative problem solving, and elements of mathematics, biology, and chemistry.

Assessment will be by theory and practical examination in the form of three three-hour papers sat in Trinity Term.

Field training takes place in Dorset before Michaelmas Term and in Assynt, Scotland, at Easter.

**Tutorials**

The normal frequency of tutorials in the 2nd year is on average one per week.

**Practical Work**

Please note students should keep hold of any practical work (lab notes, field notebooks etc.) undertaken throughout the year, as 3rd year students may be required to hand in all practical work from 2nd and 3rd year following the Part A2 examinations at the end of 3rd year.

**Examinations**

Please see Appendix 1: Examining Conventions.
# COURSE STRUCTURE

## 2nd year, 2019-20

<table>
<thead>
<tr>
<th>Michaelmas Term</th>
<th>Hilary Term</th>
<th>Trinity Term</th>
</tr>
</thead>
</table>
| **Paper 1 (A14627W1)**  
Earthquakes & Faulting  
JH  
8L + 8P | **Paper 3 (A14627W1)**  
Structural Geology & Map Interpretation  
CM/MD/RW  
16P |  |
| **Paper 1 (A14627W1)**  
Geophysical Methods  
CM/KS  
16L | **Paper 1 (A14627W1)**  
Remote Sensing & Active Tectonics  
RW 8L + 8P |  |
| **Paper 1 (A14627W1)**  
Thermodynamics  
BW 8L + 8P | **Paper 2/3**  
(A14628W1/A14629L1)  
Igneous Petrology  
DMP 8L + 8P |  |
| **Paper 2 (A14628W1)**  
Isotope Geology  
DP/RR  
8L + 8P | **Paper 2 (A14628W1)**  
Metamorphic Petrology  
CMN 8L + 8P |  |
| **Paper 2/3**  
(A14628W1/A14629L1)  
Sedimentary Geology: Sedimentary Processes  
SR/NJT 8L + 8P | **Paper 2/3**  
(A14628W1/A14629L1)  
Sedimentary Geology: Diagenetic Processes  
NJT 10L + 12P | **Paper 2/3**  
(A14628W1/A14629L1)  
Sedimentary Geology: Environments & Stratigraphy  
RB/SR 5L + 9P |
| **Paper 1 (A14627W1)**  
Evolution  
RB/ES 6L | **Paper 1 (A14627W1)**  
Mathematical Tools  
CB 8L + 16P | **Paper 1 (A14627W1)**  
Mathematical Tools  
IA 8L + 16P |

Fieldtrips:  
Dorset  
Assynt  
L=Lecture  
P=Practical
Course Synopses and Reading Lists

Books used in each lecture course may be ranked as: Essential (***); Useful (**); Supplementary (*). Numbers in bold type indicate the shelf-mark of each book. There should be a reference copy of each title in the “Confined Cupboard”. Loan copies will also usually be available and will have the same shelf location. (Check the online catalogue – OLIS – for copies in other libraries). It is easy to recall books that are out on loan using the yellow cards found in the library.

Further reading (e.g. research papers) will be provided in lectures.

Details of all courses, including reading lists and lecturers, may be subject to change by individual instructors.

Earth Deformation & Materials

Remote Sensing and Active Tectonics/Earthquakes & Faulting

Prof R Walker & Prof J Hawthorne

Remote Sensing (RTW)
L1. Introduction to Remote Sensing; active vs passive imaging; electromagnetic waves, solar and black body radiation; interaction with earth materials.
L2. Remote-sensing satellites, orbits and imaging instruments/sensors; types of imaging resolution; examples of optical satellites.
P1. Introduction to ER Mapper. Contrast enhancement, spectral bands and reflectance properties of the surface.
L4. Topography (stereo images, radar); digital elevation models; topographic distortions; comparisons with other elevation models (LiDAR, SfM).
P2. Tectonics, topography and normal faults. False colour images and DEMs

Book

Theory of faulting (JH)
L5. Basic theory of tensors: simple physical examples, transformations, principal values, new notation.
L6. Traction on surfaces; the stress tensor; principal stresses and stress axes; conventions and states of stress.
P3. Manipulating stress and strain tensors.
L7. Mohr circles; transforming stresses: pure and simple shear; invariant properties.
L8. Failure (Griffith, Coulomb) criteria; initiation of faulting; Byerlee’s law; Anderson’s theory of faulting; effects of pore fluid pressures; fault dips.

Book

Earthquakes (JH)
L9. Making the link between faults and earthquakes, focal mechanisms. Elasticity; P and S wave speeds.
L10. Earthquake mechanisms: refraction; wave propagation and the ray parameter; P-wave take-off angles and azimuths; equal-area projections of focal mechanisms; strike, dip and rake.
P5. Earthquake mechanisms: readings of first arrivals; take-off angles, azimuth and distance; stereographic projection; fault type.
L12. Continental earthquakes: dynamic friction, stick-slip motion, ductile deformation, the brittle-ductile transition, the seismogenic layer; fault scaling and growth.

P6. Earthquakes and crustal strain.

Reading:

Active Tectonics (RTW)
L13. Regional tectonics, overview: earthquake mechanisms, topography and patterns of deformation for the Alpine-Himalayan belt, western USA, New Zealand.

L15. Role and geomorphology of strike-slip faulting: examples and case studies from Iran, Tibet, Turkey, California and New Zealand.
L16. Continental shortening. Geomorphology of thrust faulting. Examples and case studies from New Zealand, Iran, the Caucasus.

P8. Active faulting and folding in central Otago, New Zealand: evidence from imagery, topography and drainage patterns.

Reading:

Structural Geology and Map Interpretation
Prof C MacNiocaill, Prof M Daly & Prof R Walker

This practically-oriented course deals with the techniques of structural geology, the interpretation of geological maps in structurally complex terrain and the construction of cross-sections in fold-and-thrust belts. It contains useful preparation for the Assynt field course and for independent mapping projects.

Reading:

Online reading list:
EARTH_MEarthSci_2nd Year_Earthquakes, Faulting and Tectonics, Structural Geology and Map Interpretation
http://readinglists.bodleian.ox.ac.uk/lists/61A2AC48-EF69-FBF7-9E13-7CF8C6670BD1

Petrology & Sedimentology

Sedimentary Geology

Sedimentary Processes (Michaelmas Term):
Prof S Robinson & Prof N Tosca

This course aims to develop a comprehensive understanding of the physical, chemical, and biological processes that generate sediments at the Earth’s surface, building on knowledge gained in year 1. The course examines the production of siliciclastic grains, the mineralogy and origin of limestone particles, and finally, by using thermodynamic principles and aqueous geochemistry, a quantitative understanding of the chemical controls on the generation of carbonate and evaporite sediments. Emphasis is placed on the petrographic identification of these sediments as well as secular changes through Earth history.

Practicals will involve a combination of petrographic examination of thin sections and group problem solving.
The course will not use a single textbook but will rely on several, as well as the primary literature.

Topics: Siliciclastic grains, origin of limestone particles, mineralogy and genesis of oolites, chemical and thermodynamic principals of Earth surface systems, aqueous solutions, mineral-water equilibria, the carbonate system in seawater, and the chemistry of evaporite deposition.

Suggested texts:

Diagenetic Processes (Hilary Term)
Dr Nick Tosca
Room 50.07, Earth Sciences Building
nick.tosca@earth.ox.ac.uk

Content
There are 8 lectures in this section and 4 two-hour labs devoted to recognising diagenetic products in sedimentary rocks using optical microscopy. The lecture material focuses on developing a sound understanding of the diagenetic processes that influence all of the major types of sedimentary rocks, and how diagenetic histories can be reconstructed through petrographic analysis.

Aims
• To understand the physical and chemical changes involved in early and late diagenesis of sediments
• To understand why diagenetic change occurs in various sediment types
• To become proficient in the petrographic analysis of diagenetic products in all major sedimentary rocks
• To understand why temporal / spatial shifts in diagenetic products have occurred through Earth history

Lectures
Lecture 1: Introduction to diagenesis
Lecture 2: Diagenesis of carbonates on the seafloor
Lecture 3: Diagenesis of carbonates in meteoric water
Lecture 4: Dolomite & dolomitization
Lecture 5: Origin & diagenesis of siliceous sediments
Lecture 6: Diagenesis of terrigenous clastic sediments
Lecture 7: The role of redox in early diagenesis
Lecture 8: Origin & diagenesis of sedimentary Fe deposits

Labs
Laboratory 1: Petrography of marine carbonate cements
Laboratory 2: Petrography of meteoric carbonate cements
Laboratory 3: Petrography of dolomite & siliceous sediments
Laboratory 4: Petrography of terrigenous clastic sediments & Fe-deposits
A note about doing well in this course
The lectures will mainly discuss diagenetic processes and optical criteria for their recognition in major sedimentary rocks. I will use as many visual examples as time allows in the lectures. However, true proficiency can only come with time spent behind the microscope with well-characterised examples. Therefore, it is up to you to put the time in outside of class and become comfortable in recognising the products we discuss. The two AAPG “Color Guides” are valuable resources to use when behind the microscope. Contact me if you would like additional resources to work with on your own time, or if you would like tutorials on this material.

Environments and Stratigraphy
Prof S Robinson & Prof R Benson
This course will look at the tool used by geologists to understand past environments, timescales and environmental change. Lectures and practical classes will focus on:

- Reefs and faunal assemblages
- Trace fossils and environments
- Plankton and pelagic sediments
- Plants and coals
- Principals of stratigraphy, biostratigraphy and seismic stratigraphy
- Sedimentary facies analysis and graphic logs
- Construction of the Global Time Scale

Suggested Texts:

Online reading list:
EARTH_MEarthSci_2nd year_Sedimentary Geology
http://readinglists.bodleian.ox.ac.uk/lists/7C4252EF-AF62-C4A9-84DD-051BCC3A054D

Igneous and Metamorphic Petrology

Igneous and Metamorphic Petrology
Prof D Pyle & Prof C MacNiocaill
The igneous section of the second-year petrology course covers: revision of igneous rocks in hand specimen and thin section. Use of simple phase diagrams to understand the origin and evolution of igneous rocks, including crystallisation and melting paths under equilibrium and fractional conditions. Outline of the main controls on magmatism and magmatic rocks in different tectonic settings.

The metamorphic section of the course builds on the study of mineralogy and petrology begun in the first year, and serves as a solid basis for the interpretation of mineral assemblages and textures of metamorphic rocks. Topics covered include: equilibrium and disequilibrium, metamorphic reactions, graphical analysis of phase relations, estimating pressure and temperature of equilibration, inferring P-T-time-deformation histories, metamorphic fluid composition and phase relations, fluid-rock interaction. Extensive support materials are available in the section ‘Metamorphic Petrology’ at https://weblearn.ox.ac.uk/x/4ehrfP and on ORLO.

Reading:

Online reading list:
EARTH_MEarthSci_2nd year_Igneous Petrology
http://readinglists.bodleian.ox.ac.uk/lists/99802012-8386-70AA-D449-9F4803F73245

EARTH_MEarthSci_2nd year_Metamorphic Petrology
http://readinglists.bodleian.ox.ac.uk/lists/6FC293C1-A69A-C971-F30F-36544050DE60

Geochemistry & Ocean Chemistry

Thermodynamics
Prof B Wood

The thermodynamics part of the course will cover: Thermodynamic functions; chemical potential; free energy; entropy; enthalpy and heat capacity. Hess’s law; stable and unstable mineral assemblages. Solid-solid reactions; calculation of simple phase diagrams. Fluids; perfect gas laws; pressure-volume-temperature relationships for imperfect gases; fugacity. Calculations and reactions involving fluids and solids. Activity and standard states; Activity-composition relations for ideal and non-ideal solid solutions. Aqueous solutions; ions and complexes; solubility, Redox potential.

Reading:
Elementary thermodynamics for Geologists by B.J. Wood and D.G. Fraser. 21A.37

Isotope Geology
Prof D Porcelli & Prof R Rickaby

This course covers the use of radiogenic isotope chemistry for geological dating, including methods for determining: the age of the Earth, rock formation and metamorphism ages, early solar system chronology, 14C ages, exposure ages, the rates of continental growth and planetary degassing, thermal histories of crustal rocks, and the rates of volcanic and environmental processes. Using isotopes for identifying different processes and tracing in the environment and within the Earth is also covered.

The Carbon Cycle
ANO

Each session will combine lectured material with hands-on material for the students (calculations, computer exercises, etc.). Some will also feature practical demonstrations. The course will occasionally use carbon-isotope data (δ13C and 14C).

The course will not use a single text book, but rely on several, on the primary literature, and on web resources.

The course will cover: Introducing the C cycle; The long-term C cycle; The terrestrial biosphere; The ocean biosphere; Inorganic carbon in the ocean; Glacial-interglacial change in atmospheric CO2; The 20th Century; and The future carbon cycle.

Online reading list:
EARTH_MEarthSci_2nd year_Geochemistry and the Carbon Cycle
http://readinglists.bodleian.ox.ac.uk/lists/09574222-3669-DEB4-EBBD-0C854C923A5F

Mathematical Tools & Geophysical Methods

Mathematical Tools
Prof C Ballentine & Dr I Ahmed

This course will: (i) review basic quantitative tools required for data analysis across the earth sciences; and (ii) provide a working introduction to MATLAB. Major topics to be covered include: probability;
statistical testing; parameter estimation; regression models; time-series analysis; ordinary differential equations; Fourier series; heat equation; wave equation; box models.

Laboratory sessions designed to provide hands-on experience with MATLAB will complement weekly lectures.

Reading:

Davis, J. C. Statistics and Data Analysis in Geology (2002). 9C.13

Geophysical Methods
Prof C MacNiocaill & Prof K Sigloch

An introduction to gravity, magnetic, and seismic methods of geophysical exploration. Instrumentation and field survey design. Data reduction and processing techniques. Geological interpretation of gravity, magnetic and seismic reflection and refraction data.

Reading:

McQuillin, R., Bacon, M. & Barclay. (1979) An introduction to seismic interpretation. 2C.106

Online reading list:
EARTH_MEarthSci_2nd year_Mathematical Tools and Geophysical Methods
http://readinglists.bodleian.ox.ac.uk/lists/B5E4D2BD-6BD1-2F53-370A-D02E12F982E2

Evolution
Prof R Benson & Prof E Saupe
6 Lectures

Lectures will introduce key evolutionary concepts that are important for well-rounded Earth Scientists, including the evidence that led Darwin to the theory of evolution, the mechanisms of heredity, population genetics, species concepts and speciation, and phylogenetics. This information will be parsed into the following lectures:

1. Darwin and the origin of evolutionary thought
2. Heredity and population genetics
3. Species, speciation, and levels of selection
4. Macroevolution and biogeography
5. Phylogenetics and calibrating the fossil record
6. Great transformations (transitions to land, evolution of whales, etc)

Online reading list:
EARTH_MEarthSci_2nd year_Evolution
http://readinglists.bodleian.ox.ac.uk/lists/645E1A5B-D3B4-57BE-135C-8F5CAA9ED374

FIELD COURSES

Health Issues

If students have any health issues that may affect their participation in a field course, they will be asked to provide a letter from their GP confirming that they are fit to participate in the various aspects of the course (a list of specific points for your GP to respond to will be provided). It is the responsibility of the student to ensure that the field course leader and academic administration staff are aware of their
health issues. The student should ensure they discuss with them how their health issues might affect participation in the field course and any special requirements that need to be addressed, in good time before the field course.

Alternative Travel Arrangements

We encourage students to travel with the main group as much as is practicable.

Students who do not intend to travel as part of the main group for field courses, must inform the Academic Office as soon as possible. Students must make their own arrangements to and from an agreed location (such as the airport or accommodation), and they must work around the timings for the group, for example, if the course includes a flight, the student must arrive before or at the same time as the group so as not to cause a delay, and on the return they must depart at the same time or later than the group.

For courses with flights, students can be reimbursed for their alternative travel arrangements up to the cost of the flights per person on the group booking, minus any cost that the department may have already paid and cannot reclaim. An Expenses Claim form must be completed, signed, and submitted to the Academic Office with original itemised receipts (https://finance.admin.ox.ac.uk/claiming-expenses-departmental-guidance).

For courses without flights, alternative travel arrangements would be at the student’s own expense as we would still have the cost of the coach.

Dorset

This seven-day field course focuses on the Mesozoic (Triassic-Cretaceous) sedimentary rocks deposited during the development of the Wessex Basin and the younger Cenozoic (Eocene) rocks of the Hampshire Basin. The rocks are spectacularly exposed in cliff sections along the East Devon and Dorset coastline, and are examined at Budleigh Salterton, Ladram Bay, Lyme Regis, Charmouth, West Bay (Bridport), Portland, Durdle Door, Lulworth Cove and Hengistbury Head (near Bournemouth). The focus is on the sediments and the fossils they contain, with a view to interpreting ancient environments and the origin of the sedimentary basin in the context of Mesozoic and Cenozoic earth history. Also of interest are the geological conditions that led to the formation of oil reserves in this region.

The course reinforces many fundamental aspects of geological observation and acquisition of field data that were introduced in year 1. In the evenings, time is spent analysing data collected during the day, and learning about related research studies in this area.

Reading:


Online reading list:
EARTH_MEarthSci_2nd year_Field Trip: Dorset
http://readinglists.bodleian.ox.ac.uk/lists/05209292-5A1B-2CE6-E8F8-FD9EA78279BF
Worbarrow Bay, Dorset. The Late Jurassic to Cretaceous sediments were folded during earth movements related to the Alpine mountain-building.

Assynt

The far north-west of Scotland is an area of classic geology, containing one of the first major overthrust zones to be recognised, and an area of intensively studied Precambrian gneisses widely regarded as a model for the nature of the lower continental crust. The course has a number of objectives:

1. Training in a variety of geological mapping techniques involving a range of rock types and geological settings, including highly deformed rocks and metamorphic terrain, in preparation for students’ independent work.
2. An opportunity to link the study and description of rocks in the field with examination of the same rocks in the laboratory.
3. A study of the geological evolution of north-western Britain through about three billion years of Earth history.
4. The acquisition, processing and geological interpretation of gravity and magnetic data.
Precambrian red sandstones, laid down by river systems 1000 million years ago, make up the bulk of the mountain Quinag.

The principal focus of the course, however, is on recording information, and on the techniques of geological mapping. Mapping is one of an Earth scientist’s most fundamental skills. It comprises the ability to record and interpret the three-dimensional patterns and relationships of rock bodies, and to work out the sequence of events that formed them. As part of the training, students learn:

- to record information in a field notebook: descriptive notes and measurements of thickness, distance, orientation.
- to make detailed and clearly labelled sketches of features seen in outcrop, with interpretation.
- to record outcropping rock types, measurements and other data on field slips - copies of topographic base maps taken into the field.
- to make interpretive sketches of the geological features of a large area by making “sky-line cross-sections” from panoramic views.

We learn and practise a variety of mapping techniques:

- Mapping an area of a few square kilometres by visiting essentially all outcrops and tracing out geological boundaries by observation and inference.
- Walking a traverse across a succession of rock types, collecting information for constructing a geological cross-section.
- Mapping well-exposed areas of outcrop in detail by pace-and-compass traverse and grid mapping.
- Logging sedimentary successions in continuous coastal outcrop.
- Mapping and measuring folded and metamorphosed rock sequences, and inferring complex three-dimensional structure.

On return from the field, students learn to compile a final version of the geological map from their field slips and recorded data, adding further interpretation in the form of cross sections and an account of the geological history. The field centre at Inchnadamph provides laboratory space to follow up field observations by studying the rocks of the area in hand specimen and under the microscope.

This course also includes professional instruction on fieldwork safety and survival in remote and rugged terrain.

**Reading:**
- Woodcock, N. & Strachan, R. (eds.) Geological History of Britain and Ireland, Blackwell. -3B.153

**Online reading list:**
EARTH_MEarthSci_2nd year_Field Trip: Assynt
http://readinglists.bodleian.ox.ac.uk/lists/AD0AF7DD-9A6B-110C-AD9D-4FBF7F0BAE12
Inchnadamph Lodge, the Assynt field centre, looking towards Canisp mountain.

Looking for the unconformity: on the right, banded metamorphic gneisses formed in the deep crust, uplifted, eroded, and locally covered by a veneer of sediment; on the left, shallow-dipping siltstones and sandstones of the 1200 million-year-old Stoer Group, which overlie the gneiss.
Independent Mapping Project

OVERVIEW

All students undertake an independent mapping project during the summer vacation at the end of their second year. The project consists of 4-6 weeks of geological mapping of an area of 11-15 km² in a location of the students’ choice. In recent years, students have mapped in areas as diverse as New Zealand, Alpine Europe, Northern Norway, Greenland, as well as the British Isles.

In addition to mapping, specialised investigations should also be undertaken, involving further study such as structural analysis, petrology, palaeontology, or sedimentology. The mapping area should be reasonably compact and have a sufficient degree of natural or artificial exposure to allow effective mapping at the scale you choose. It should contain distinct and mappable rock-types, and lack large areas of uniform lithology. There should be a sufficient level of stratigraphic or structural complexity to present a challenge. The rocks need not span a wide range of ages: lateral facies variations within a single stage, complex structure, or detailed intrusive and extrusive relations in an igneous centre, could all be suitable for mapping. Areas where recent detailed maps have been published are in general best avoided.

For reasons of safety, you are required to organise yourselves into pairs. Although you will be mapping together during the day, all observations must be marked individually on your field-sheets and the projects will be written up individually. We recommend that in Michaelmas term, students start to think about where they would like to map and consult as widely as possible with members of staff about their chosen areas. We also recommend that pairs organise themselves into groups of 4 or more to map adjacent areas. In addition to the mapping, a specialised investigation of some aspect of the geology in your field area should be undertaken, which might involve detailed structural, palaeontological, or sedimentological analyses.

Final approval of the projects takes place at the end of Hilary Term of the 2nd year when each student meets with the mapping committee, who assess the projects in terms of the geological suitability, logistics and, most importantly, safety. In addition, risk assessments are carried out on all the areas.

The aim is to produce

(i) a field map, normally drawn on a topographic base (aerial photographs may be used as an aid in mapping where available). If a topographic base is unavailable, you may construct a base from aerial photographs (subject to the panel’s approval). If the only available topographic base does not include contours, then you should make some attempt to show the topography.

(ii) a field note-book(s). This should be a sturdy hard-backed notebook, and be kept tidy and legible. Grid-references or other information should be included to allow notes to be keyed to your maps. Field sketches should have scales and orientation.

(iii) structural sections and sedimentological logs. These should be drawn up as far as possible while you are in the field area.

(iv) a collection of representative rock specimens, (about fist-sized and as fresh as possible) from which thin sections may be prepared, and photographs of outcrops and landscapes to supplement field sketches.

(v) In the report on the mapping project the student’s main task is to explain clearly the geology of their area, taking a reasonable account of previous literature. At the same time they have to show they have done a good job in the field, and can interpret their observations both critically and imaginatively, and with good scientific sense: no easy matter!

Students will be given £400 towards the cost of their Summer Mapping (£300 subsistence and £100 travel). Payments will be made by BACS in Trinity Term.

Students must have travel insurance regardless of their destination. This can be as part of a family scheme, bought independently or via the University Scheme (which currently costs £15 for 30 days cover). Students must submit an insurance application form online, or provide a photocopy of their insurance document along with their risk assessment form to the Academic Administration Office.

In exceptional circumstances, such as when there are health issues which make it difficult to go into the field, students may have the option of undertaking a desk-based mapping exercise over the long vacation instead of field mapping. Students who feel they have sufficient reasons to undertake a desk-based mapping exercise should raise this with their tutor as early in 2nd year as possible, and submit a case for consideration by the Teaching Committee. However, the terms of the accreditation of the degree course by the Geological Society of London include a requirement that students undertake a period of independent field work, and it is not usual practice for students not to complete a field project.
Health Issues

If students have any health issues that may affect their participation in field work, they should discuss this as soon as possible with their tutor and the Mapping Panel. It is the responsibility of the student to ensure that they raise any health issues well in advance of the summer mapping exercise. They may be asked to provide a letter from their GP confirming that they are fit to participate in the mapping exercise.

ROGER WALLING FUND

Limited funds are available from the Roger Walling Fund to support mapping, and one student may obtain an additional £100 towards their mapping exercise. Application is via a form, which should be emailed to Emma.Brown@earth.ox.ac.uk by 4pm on Monday of Week 9 of Trinity Term. The form can be downloaded from Weblearn:

https://weblearn.ox.ac.uk/portal/site/%3Ampls%3Aearth%3Augrad%3Ayr2/page/3c935e12-753a-430f-af04-41d5e9af1ce

We will aim to notify applicants of the outcome by the end of June.

BEFORE TRAVELLING - A CHECKLIST

(i) Attend the talk on safety in the field (you will need to sign a form to show that you have done so).

(ii) Complete the Independent fieldwork risk assessment form (see and discuss your plans, in depth, with the Field Teaching Officer - Dr Stuart Robinson, who will be particularly concerned with safety). The panel will want to be assured that you are aware of potential hazards in the area, and that you have planned suitable control measures to reduce risks to an acceptable level.

(iii) Complete the University Travel Insurance form.

(iv) Demonstrate that you have suitable clothing and footwear and other necessary equipment.

(v) Collect the safety pack loaned by the department (against a deposit), consisting of a whistle, survival bag, torch, and spare batteries. In addition, it is highly desirable to have a mobile telephone, though they may not always work in remote mapping areas. Also collect other documentation (safety information, addressed envelope, names and telephone numbers of members of the department who can be contacted while you are in the field).

(vi) Hand in the information sheet, giving details of the precise location of your mapping project, the names of all members of your group, where you are planning to stay and any points of contact, and the dates of your field work, and also a preliminary assessment of likely hazards in the mapping area.

(vii) In addition, you are strongly advised to discuss your plans widely, especially with your College tutor and anybody close to you (family, friends etc.) - this way you will be able to take into account a wide range of experience and points of view before going to your mapping area.

IN THE MAPPING AREA

- As a group undertake a reconnaissance of each mapping area. Use your initial reconnaissance to update your risk assessment. Record in your field notebook any amendments to the nature and severity of hazards and how you plan to address these hazards to minimise the risks.

- Return the addressed envelope with your updated address, dates of mapping, and any new information about potential hazards in your mapping area. If you don’t feel confident about working in the area at this stage, you should take appropriate and sensible action. Use your common sense - you are ultimately responsible for your project, including your own safety in the field.

- In the same place as the rest of the group, exchange information each day, and inform a local independent party (hostel guardian, policeman, shopkeeper) where you plan to map and what time you expect to return.

- Further notes on mapping technique:

https://weblearn.ox.ac.uk/portal/site/%3Amps%3Aearth%3Augrad%3Ayr2/page/54be44f8-3f15-49c4-8a5c-2472ad92f352
are also available.

- The department will allow for up to 6 thin-sections to be prepared for you, so collect samples with this in mind. If you have carbonate rocks, you may also be able to make your own acetate peels for microscope investigations.

**HANDING IN THE PROJECT**

Students are expected to cut their own samples, in preparation for the creation of thin sections, at the beginning of the Michaelmas term of their 3rd year. Thin sections will be returned to students later in Michaelmas Term.

We are also asking students to hand in an electronic copy of their project and their field notebook. We would suggest that, whilst in the field, each day students photograph the pages of their field notebook they have completed that day, and take a scan of the full field slips as soon as possible. Disks will be available from Reception to burn the scanned copy to. This should be handed in to Emma Brown in room 10.33 by 4pm on Thursday of Week 1 in Michaelmas Term. Disks will also be made available from reception in week 0 of Hilary Term so that students may also hand in an electronic copy of their project and map.

The completed field mapping project, including the electronic copy, should be submitted to Emma Brown in Room 10.33, by 12 noon on Thursday of Week 0, Hilary Term.

To facilitate distribution among the examiners, the report and all field materials must be contained in a named SINGLE STANDARD BOX FILE.

Further details about submitting your project can be found in the appendices. This should be taken as the definitive list of items to be handed in and the format for handing them in.

The Examiners will normally award about 50% of the marks for the record of work done in the field, i.e. as recorded in notebooks and on field slips.
# THIRD YEAR COURSE

## Deadlines

Please note:

1. Some of these dates are based on previous years, and may be subject to change. Every effort will be made to notify students of any changes as soon as possible. In the meantime PLEASE PUT THESE DATES IN YOUR DIARY NOW. You may not receive further reminders about some items.

2. These deadlines relate to departmental business, and you may have other important dates relating to college business.

3. Examination and some field course dates are in italics, as they will be confirmed nearer the time.

4. Deadlines in bold are included in the examination regulations or conventions and you may be penalised by the examiners if you do not meet them. ALL EXAMINATION MATERIAL SHOULD BE HANDED IN TO EMMA BROWN OR THE ADMINISTRATIVE OFFICER IN 10.33.

<table>
<thead>
<tr>
<th>TERM</th>
<th>WEEK</th>
<th>DAY</th>
<th>TIME</th>
<th>ITEM</th>
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<tbody>
<tr>
<td>Michaelmas Term</td>
<td></td>
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<tr>
<td></td>
<td>Week 1</td>
<td>Monday</td>
<td>9am</td>
<td>Cut rock samples for thin sections to be prepared.</td>
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<tr>
<td></td>
<td>Week 1</td>
<td>Friday</td>
<td>4pm</td>
<td>Hand in scanned copy of field notebooks and field slips on disk to Emma Brown in 10.33</td>
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<tr>
<td></td>
<td>Week 4</td>
<td>N/A</td>
<td>N/A</td>
<td>3\textsuperscript{rd} year essay approval forms available</td>
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<tr>
<td></td>
<td>Week 6</td>
<td>N/A</td>
<td>N/A</td>
<td>Begin to consider 4\textsuperscript{th} year project topics, and approach supervisors if appropriate.</td>
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<tr>
<td></td>
<td>Week 8</td>
<td>TBA</td>
<td>N/A</td>
<td>Thin sections available for collection</td>
</tr>
<tr>
<td></td>
<td>Week 8</td>
<td>Friday</td>
<td>N/A</td>
<td>Return essay approval form</td>
</tr>
<tr>
<td></td>
<td>Week 8</td>
<td>N/A</td>
<td>N/A</td>
<td>Collect mapping questionnaire, for inclusion with mapping project.</td>
</tr>
</tbody>
</table>
| Hilary Term | Week 0| Thursday| 12.00 noon | Hand in mapping project to Emma Brown in 10.33  
All materials, including a copy of the project and map on disk, should be collected in one box file. All thin sections and GeoSoc questionnaires should also be handed in with the project. |
|            | Week 3| TBA     | TBA    | A list of supervisors and some suggestions for 4\textsuperscript{th} year projects will be available on WebLearn. |
|            | Week 3-7| TBA | TBA    | Briefing on 4\textsuperscript{th} year projects.                   |
|            | Week 7| Friday  | 4.00 pm| Submit application for research project.                             |
| Easter Vacation | N/A | 15-22 April | TBC | Spanish field course                                                |
| Trinity Term | Week 0| Thursday| 12.00 noon | Hand in 3\textsuperscript{rd} year essay (TWO copies) to Emma Brown in 10.33 |
|            | Week 4-6| Days TBA | Times TBA | Part A examinations                                                 |
**Tutorials**

The normal frequency of tutorials in the 3rd year is on average one per week.

**Independent Mapping Project**

**THIN SECTIONS**

The first petrology lecture of Week 1 in Michaelmas Term will be devoted to explaining the process of Thin Section Making and the arrangements for rock cutting of student samples collected during the summer. Students will be allowed a maximum of 6 thin sections. Prepared thin sections will be returned to students during Michaelmas Term (you will be jointly notified by email). Stained acetate peels of carbonate rocks may also be prepared for you. (Discuss your requests with the Geological Facilities Manager owen.green@earth.ox.ac.uk).

**DIGITAL COPY**

Students are required to hand in an electronic copy of their project and their field notebook. We would suggest that, whilst in the field, each day students photograph the pages of their field notebook they have completed that day, and take a scan of the full field slips as soon as possible. Flash drives will be available from Reception for the scanned copy. This should be handed in to Emma Brown in room 10.33 by 4pm on Friday of Week 1 in Michaelmas Term. A “hand-in” pack, consisting of flash drive, box file and packaging for thin sections, will also be made available from reception in week 0 of Hilary Term for students to hand in the physical and digital copies of their project and map.

Further details about submitting your project can be found in the appendices. This should be taken as the definitive list of items to be handed in and the format for handing them in.

**Practical Work**

Please note students should keep hold of any practical work (lab notes, field notebooks etc.) undertaken throughout the year, as 3rd year students may be required to hand in all practical work from 2nd and 3rd year following the Part A2 examinations at the end of 3rd year. It is no longer a requirement to hand in practical work, but the examiners reserve the right to request it. Therefore students should ensure they have their work from 2nd and 3rd year available to hand in, if requested, in Trinity Term. If the examiners wish to see practical work, they will make a request between Wednesday and Friday of Week 7 in Trinity Term.

**Third Year Essay**

As part of the third year course, students complete a 4000-word essay on a substantial scientific problem of their choice that is sufficiently unresolved to allow scope for critical evaluation and independent thought. The topic should be refined in discussion with a member of staff. The extended essay is understood by the examiners to be an independent piece of work and written according to the structure and style of a review paper. For example, see the “information for authors” for the journals: Earth Science Reviews:

http://www.elsevier.com/wps/find/journaldescription.cws_home/503329/authorinstructions

and the Journal of the Geological Society:

http://www.geolsoc.org.uk/jgs_authorinfo
These provide suggestions of the style, presentation and layout which are appropriate for this essay.

Third year essay are entirely independent, and no tutorials may be provided nor any input given by the tutor beyond initial definition of the subject area.

The examiners will reward very clearly written essays that assimilate existing information and demonstrate critical skills, familiarity with and understanding of a significant amount of primary literature, originality, and well-argued independent thought.

The Academic Administration Office will ask you to complete a questionnaire on your 3rd year essay subject area towards the end of Michaelmas Term, via Weblearn.

The arrangements for approving essay titles and for regulating the amount of interaction with members of academic staff are laid down by the Faculty's Teaching Committee.

Further information about submitting your essay is available in the appendices.

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**Examinations**

Please see [Appendix 1: Examining Conventions](#).
COURSE STRUCTURE

3rd year, 2019-20

Each student takes 6 papers, plus 1 fieldwork paper

<table>
<thead>
<tr>
<th>Michaelmas Term</th>
<th>Hilary Term</th>
<th>Trinity Term Revision</th>
</tr>
</thead>
</table>
| Paper 2 (A10639W1) Natural Resources  
LR 8/4  
JC 12 | Paper 1 (A10638W1) Sedimentary Basins  
JC/MD/BL 24 | Paper 10 (A13476W1) Fieldwork & Interdisciplinary  
(no lectures) |
| Paper 3 (A10647W1) Biological & Physical Oceanography  
HB/HLJ 24 | Paper 6 (A14882W1) Volcanology, Igneous Processes & Petrogenesis  
DMP/TM 24 | |
| Paper 4 (A13477W1) Climate  
RR/CD/SK 24 | Paper 7 (A13478W1) Quantitative Palaeobiology  
RB/ES 24 | |
| Paper 5 (A14883W1) Seismology & Earth Structure  
TNM/KS 12 | Paper 9 (A14884W1) Geodynamics  
RK 12L, 6P  
PCE 12 | |
| Paper 5 (A14883W1) Vector Calculus  
TNM 12 | | |
| Paper 8 (A10643W1) Earth Materials, Rock Deformation & Metamorphism  
DJW 24 | | |

Fieldtrips:
- Spain

L=Lecture
P=Practical
Third Year Course Synopses and Reading Lists

Details of all courses, including reading lists and lecturers, may be subject to change by individual instructors.

Prerequisites for 3rd year options

It is RECOMMENDED that students take Vector Calculus in preparation for the Geodynamics & Continental Deformation option.

Prerequisites for 4th year options

4th year options have the following prerequisites:

Paper 1: Palaeobiology - it is recommended students take the 3rd year Vertebrate Palaeobiology option, but students who wish to take the 4th year option will be considered on a case by case basis.


Paper 3: Structure & Dynamics of the Earth’s Mantle - it is recommended that students take Geodynamics and Continental Deformation in the 3rd year, but reading can be suggested if they have not.

Paper 4: Major Environmental Change - none.


Paper 6: Anatomy of a Mountain Belt - it is useful but not essential for students to take the 3rd year Earth Materials and Continental Deformation options.

Paper 7: Topics in Volcanology - it is recommended that students take the 3rd year Volcanology option, but reading can be suggested if they have not.

Paper 8: Topics in Oceanography - it is recommended that students take the 3rd year Biological & Physical Oceanography option, but reading can be suggested if they have not.

Paper 1: Sedimentary Basins

Prof J Cartwright, Prof M Daly & Prof B Levell
12 Lectures, 12 Practicals

The aim of this course is for students (1) to be able to describe a sedimentary basin in terms of its sedimentary fill and structural geology and (2) to understand, in broad outline, the lithospheric processes that govern the formation of sedimentary basins, and the processes that lead to the filling of those basins with sediments. The course is structured in two main parts: (1) the interpretation of seismic sections across sedimentary basins (2) the interactions among the processes of relative sea level, change, (primarily addressing subsidence) and sediment supply.

Practicals provide an opportunity to use seismic and well data to infer the stratigraphic and structural evolution of sedimentary basins, to reconstruct subsidence histories and to place basin evolution in a wider tectonic context.

Suggested Text:

Online Reading List:
EARTH_MEarthSci_3rd year_paper 1: Sedimentary Basins
http://readinglists.bodleian.ox.ac.uk/lists/D77F9063-CE6A-056D-4F03-DC2D4BF240C8

Paper 2: Natural Resources

Prof L Robb & Prof J Cartwright

Subsurface Mapping and Petroleum Geology
Prof J Cartwright

This programme will include lectures from external speakers working in the petroleum industry.

Suggested Texts:
Sheriff, R.E. & Geldart, L.P. Exploration seismology. (2nd ed.) (Chapters 5, 11 & 12 only.) - 2C.253

Introduction to Ore Forming Processes
Profs L Robb and D Waters

This is a 4 week course aimed at providing an introduction to the processes by which metals are concentrated in the Earth’s crust, and the tectonic settings within which these processes take place. It comprises a combination of lectures and practicals, the latter designed to illustrate, by combined transmitted and reflected light microscopy, the nature of ore minerals and their host rocks

Outline
Magmatic ore forming processes [crystal fractionation, partial melting, liquid immiscibility]
- 4 lectures; 1 practical
Magmatic-hydrothermal ore forming processes [nature of magmatic aqueous fluids]
- 3 lectures; 1 practical
Hydrothermal ore forming processes [solubility, metal complexation, precipitation mechanisms, hydrothermal alteration]
- 3 lectures; 1 practical
Sedimentary ore forming processes [hydrodynamics and placer processes]
- 1 lecture; 1 practical
Global tectonics and metallogeny [crustal evolution; supercontinent cycle, plate tectonics and ore formation]
- 4 lectures

The exam will be by essay.

General Texts
[all 3 editions contain classic papers on hydrothermal ore forming processes]
Biological Oceanography
Prof H Bouman
12 Lectures
This course aims to explore some of the basic principles of biological oceanography. The course will explore the relationship between the physicochemical properties of the marine environment and planktonic communities, including phytoplankton, bacteria, and zooplankton. The use of in situ and satellite observations to study the spatial and temporal patterns in the distribution and abundance of marine organisms will be explained through both lectures and practical demonstrations. The role of ocean biota in global biogeochemical cycles will also be discussed.

Physical Oceanography
Prof H Johnson
8 Lectures, 4 Problem Classes
8 Lectures
4 Problem Classes

L1: Observing the ocean.
L2: The wind-driven circulation revisited.
L3-4: Western boundary currents and the homogeneous model for wind-driven gyres.
L5: Vertical structure of wind-driven gyres.
L6: Structure of the overturning circulation.
L7: Multiple equilibria and abrupt change of the overturning circulation
L8: Review

The Physical Oceanography part of the course will rely heavily on the material taught in Planet Earth (Physics of the Atmosphere and Ocean) which you should review before we get started.

General themes and outcomes
The Biological Oceanography part of the course aims to explore some of the basic principles of biological oceanography. The course will explore the relationship between the physicochemical properties of the marine environment and planktonic communities, including phytoplankton, bacteria, and zooplankton. The use of in situ and satellite observations to study the spatial and temporal patterns in the distribution and abundance of marine organisms will be explained through both lectures and practical demonstrations. The role of ocean biota in global biogeochemical cycles will also be discussed.

The Physical Oceanography part of the course explores simple dynamical models that explain the observed structure and underlying causes of the large-scale ocean circulation.

Practicals and techniques learned/used
Manipulation of equations and basic calculations. Computational analysis of data. Scientific reasoning.

Suggested Texts

Physical Oceanography
Students do not need to buy a textbook but will find helpful material in the following, which are all available in the Department and College libraries:

- Ocean Dynamics and the Carbon Cycle, Williams and Follows, Cambridge University Press
– an excellent book that covers the material in this module at an appropriate level.

- *Atmosphere, Ocean and Climate Dynamics*, Marshall and Plumb, Elsevier
  – another really good resource for this module.

  – a free textbook (http://oceanworld.tamu.edu/home/course_book.htm) that covers some of the material and can be downloaded as a PDF.

  – contains a thorough and reasonably up-to-date overview of physical oceanography.

- *Ocean Circulation*, Open University Course Team, Pergamon Press
  – gives a very good introduction to some of the more basic dynamical concepts, with very few mathematical details.

- *Atmospheric and Oceanic Fluid Dynamics*, Vallis, Cambridge University Press
  – a good textbook that covers all the material in this module including mathematical derivations, although aimed at a higher level.

**Online Reading List:**
EARTH_MEarthSci_3rd year_ Paper 3: Biological and Physical Oceanography
http://readinglists.bodleian.ox.ac.uk/lists/54664247-5DEA-6D09-2CD3-CC7A130F293F

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**Paper 4: Climate**

Prof R Rickaby, DR C Day & Prof S Khatiwala

**Week 1.** Long-term climate change *(Rickaby)*
Lecture: Overview of climate history and onset of glaciation
Lecture: Ocean gateways
Practical: Pleistocene evolution of climate

**Week 2.** Orbital climate change *(Rickaby)*
Lecture: Orbital change
Lecture: Ice-sheet feedbacks
Practical: Orbital time-series and age models

**Week 3.** Pleistocene climate: Terrestrial changes *(Day)*
Lecture: Monsoons
Lecture: Solar influences
Practical: Terrestrial climate records

**Week 4.** Pleistocene climate: Marine changes *(Rickaby)*
Lecture: MOC
Lecture: El Nino
Practical: Ice-core climate records

**Week 5-6.** Modelling climate and climate sensitivity *(Khatiwala)*
Lecture: Greenhouse effect and radiation
Lecture: Greenhouse gas emissions
Lecture: Climate modelling
Lecture: The physics of ocean waves and El Nino-Southern Oscillation (ENSO)

**Week 7-8.** Sea-level change *(Day)*
Lecture: Sea level during glacial cycles
Lecture: Abrupt changes in sea level
Lecture: Modern change
Lecture: Glacial isostatic adjustment
Lecture: Predicting the future
Practical: Sea-level calculations

Additional reading will be provided at each lecture.
Online Reading List:
EARTH_MEarthsSci_3rd year_Paper 4: Climate
http://readinglists.bodleian.ox.ac.uk/lists/F9976A41-1C5Z-AAA2-84CC-47FD05E91F63

Paper 5: Seismology & Earth Structure/Vector Calculus

Students MUST take Vector Calculus in order to take the Geodynamics & Continental Deformation option.

Seismology and Earth Structure
Prof T Nissen-Meyer

Review of stress, strain, and their relationship.
Wave propagation in an elastic medium.
The ray approximation to wave the wave equation. Snell’s law.
Wave propagation in layered media - refraction and reflection.
Seismic travel times as a primary observable in seismology. Wave phases and travel time curves in the spherical earth.
Global earth structure.
Energy content of the seismic wave field, seismic amplitudes.
Earthquake source mechanisms.

Recommended textbook: Peter Shearer, 2009, Introduction to Seismology, Cambridge University Press. (2nd Ed) 2C.219A

Additional reading:
Aki and Richards, c.2002 Quantitative Seismology, Univ Science Books 2002 - 2C.265

Vector Calculus
Prof T Nissen-Meyer & Prof K Sigloch

Coordinate systems, index notation, vector operations, grad, div & curl, Lagrange & Eulerian perspectives, streams, line integrals, energy conservation, gravity & potentials, Gauss/Stokes integral theorems, continuity equation, Poisson & Laplace equations, Helmholtz potentials, tensors, time-dependent partial differential equations.

Suggested Texts:
The course revolves around a comprehensive manuscript to be handed out/emailed during the lectures.


Online Reading Lists:
EARTH_MEarthsSci_3rd year_Paper 5: Seismology and Earth Structure/Vector Calculus
http://readinglists.bodleian.ox.ac.uk/lists/98A8619A-EEAA-BC40-3A3B-6E2BD55DCC81

Paper 6: Volcanology, Igneous Petrogenesis & Petrogenesis

Prof D Pyle & Prof T Mather

General themes and outcomes
This 24-hour course will provide an understanding of the ways in which volcanoes can erupt, the products of various types of eruption, the environmental and climatic impacts of eruptions and the formation and evolution of magmas, focussing in particular on magmatism in subduction zones.

Lecture-by-lecture outline
Each 1-hour lecture is accompanied by a 2-hour problems class. The idea is to cement concepts introduced in the lecture. The topics covered in each of the 5 blocks of 3 hours are:

1. Volcanic volatiles - introduction: explores what they are, how they are measured, where they come from and the factors governing the composition of emitted gases
2. Volcanic volatiles - impacts: explores the range and timescale of different styles of volcanic emissions
3. Volcanic volatiles - eruption styles: explores the connections between magmatic volatile contents, material properties, magma dynamics and eruption styles and cyclicity
4. Volcanic eruptions: processes and deposits
5. Volcanic eruptions: case studies
6. Formation of basaltic magmas
7. Subduction zone geochemistry: processes of formation and evolution of subduction zone magmas.
8. Subduction zone geochemistry: case studies from several volcanic arc systems

Practicals and techniques learned/used
Specific skills acquired/revised will include:

- Be able to calculate volcanic fluxes from simplified field data, including the petrological method, and comment on degassing processes in light of such data
- Use volcanic degassing budget, eruption style and environmental archive data to comment on the likely impact of volcanic activity
- Conceptual understanding of magma dynamic models of degassing and eruption style
- Interpretation of processes of emplacement from volcanic deposits
- Analysis and interpretation of geochemical data from igneous rocks and minerals to understand processes of magma formation and evolution, in both ocean-ridge and subduction zone settings

Exam descriptor
Multi-part questions with some calculation, some conceptual and some descriptive parts.

Reading list
Most of the recommended reading for the course will be from published papers from the literature, which you will find in the up-to-date reading list on ORLO. Other texts which either give some appropriate background to parts of the course, or are collections of relevant research papers, include:

Textbooks
Fagents, S. et al. (2013) Modeling volcanic processes. - 26E.113
Sparks et al. (1997) Volcanic Plumes. - 26E.91 (Confined Cupboard only. Out of print. + 1 RSL Openshelf)

Online Reading List:
EARTH_MEarthSci_3rd year_Paper 6: Volcanology, Igneous Petrogenesis and Petrogenesis
http://readinglists.bodleian.ox.ac.uk/lists/BA183F68-9B5C-65A1-606A-E6DDBEE440A8

Paper 7. Quantitative Palaeobiology
Prof Erin Saupe & Prof Roger Benson

The aim of this 24-hour course is to examine the history of life on Earth and the processes that have governed its evolution. The course will provide a quantitative framework for understanding both small-scale evolutionary changes and broad-scale evolutionary processes, including speciation and extinction. Students will learn how to tell evolutionary time, to understand what the fossil record can tell us about life’s great transformations, and to interpret large-scale patterns of change over geological time. Practicals will provide an opportunity to hone analytical skills by estimating processes such as drift and selection, modelling the birth and death of lineages, and inferring phylogenetic trees.

Suggested Text:
Paper 8. Earth Materials, Rock Deformation and Metamorphism

Prof DJ Waters

Lecture by Lecture Outline:

**Rock Deformation**
4 Lectures
4 Practicals (4 x 2 hours)

Four sessions, consisting of a lecture and up to two hours of practical work, cover:

1. Principles: strain measurement and geometry, ductile deformation at the lattice scale, dislocation creep, recovery and recrystallisation, physical analysis of stress and strain.
2. Review of deformation mechanisms at the lattice and grain scales. Mechanism maps, role of temperature and strain rate. Fabric development in tectonites: foliations and lineations; controls on grain size;
3. Shear zones: geometry, fabrics, kinematics, shear-sense indicators; case studies of fabrics and deformation patterns from orogenic belts to the deep crust and mantle.

**Metamorphic Geology**
6 Lectures
6 Practicals

Six two-hour sessions, each consisting of a lecture followed by illustrative practical work:

1. Thermal metamorphism: controls and processes
2. Metamorphism in collisional orogenic belts
3. Mineralogy, phase relations and field occurrence of high-pressure rocks
4. Reaction histories and exhumation of high-pressure rocks
5. Partial Melting in the crust and the Metamorphic Petrology of Migmatites
6. Metamorphism on very high geothermal gradients: processes and P-T paths in granulites

Total 24 hours - 10 Lectures, 14 hours Practicals

General Themes and Outcomes

**Rock Deformation**
This series of lectures and practicals examines the way rocks and crystalline aggregates deform. It concentrates on ductile processes occurring at the scale of the mineral lattice and the grain boundary region. These processes are important for our understanding of the behaviour of the Earth's crust and mantle, and are reflected in the microstructures developed in geological materials. The course has, therefore, a large practical component in which students learn to identify and interpret microstructures of intracrystalline deformation, recrystallisation and fabric development. The aim is to reconstruct the tectonic evolution of rock bodies, scaling up to the orogenic belt.

**Metamorphic Geology**
This course builds on earlier courses, and deals with the contribution of metamorphic studies at a range of scales to an understanding of tectonics and crustal evolution. A wide range of topics is covered, including:

- The thermal budget of crustal regimes, isograd patterns, P-T paths and exhumation processes in collisional orogeny, with examples mainly from the Alps. (Sessions 1-2)
- Metamorphism in subduction zones, ultra-high pressure metamorphism, density changes, metastability and the fate of subducted material. Transitions from subduction to collision to exhumation. (Sessions 3-4)
• Metamorphism on high thermal gradients: melting in the crust, migmatites and melt segregation processes; granulites and their associations, e.g. magmatic arcs, extensional zones, Precambrian shields and the lower crust. (Sessions 5-6)

Practicals and techniques learned/used
This course contains a large component of practical microscopy, using facilities in the Vincent Mineralogy Laboratory. Other practical sessions include paper exercises and simple problem-solving

Exam descriptor
The examination for paper 8 consists of written essay-style and/or short-answer questions, some of which involve the interpretation of images of geological microstructures.

Suggested Texts:
• Suggested Texts for Metamorphic Geology: There is no text book as such, but a brief reading list of journal articles and review papers will accompany each session. These materials can be accessed via https://weblearn.ox.ac.uk/x/tg9zWY and on ORLO.

Paper 9. Geodynamics
Prof R. Katz & Prof P England

This course will cover the fundamental observations and theories that inform our understanding of the dynamics of the mantle and the lithosphere on geological time-scales. It will include an introduction to fluid mechanics and the principles of convection, and a discussion of advanced topics relevant to mantle convection. These topics are combined with analysis of the thermal and mechanical structure of continental and oceanic lithosphere.

Students MUST have taken Vector Calculus to take this course.

L 1-3. Fluid mechanics
L 4. The rheology of the Lithosphere.
L 5. Active tectonics: How do the tectonics of continents and oceans differ, and why?
L 6. Theories of Continental Deformation: Rigid Blocks, Plastic Lithosphere, Fluid Lithosphere
L 7 & 8. Mechanics of a thin (non-linear) fluid layer
L 9 & 10. Observational tests of theories of continental deformation: earthquakes, geodesy, geology
L 11 & 12. Applications to active deformation in the Alpine-Himalayan Belt
L 13 & 14. Rayleigh-Benard convection
L 15 & 16. Mantle convection and heat budget
L 17 & 18. Mantle flow at plate boundaries.
L 19. Mantle Convection and dynamic topography.
L 22. Temperatures on convergent plate boundaries.
L 23 & 24 Sedimentary Basins and regional metamorphism.

FIELD COURSES

Health Issues
If students have any health issues that may affect their participation in a field course, they will be asked to provide a letter from their GP confirming that they are fit to participate in the various aspects of the course (a list of specific points for your GP to respond to will be provided). It is the responsibility of the student to ensure that the field course leader and academic administration staff are aware of their health issues. The student should ensure they discuss with them how their health issues might affect participation in the field course and any special requirements that need to be addressed, in good time before the field course.

Alternative Travel Arrangements
We encourage students to travel with the main group as much as is practicable.
Students who do not intend to travel as part of the main group for field courses, must inform the Academic Office as soon as possible. **Students must make their own arrangements to and from an agreed location** (such as the airport or accommodation), and they must work around the timings for the group, for example, if the course includes a flight, the student must arrive before or at the same time as the group so as to not cause a delay, and on the return they must depart at the same time or later than the group.

For courses with flights, students can be reimbursed for their alternative travel arrangements up to the cost of the flights per person on the group booking, minus any cost that the department may have already paid and cannot reclaim. An Expenses Claim form must be completed, signed, and submitted to the Academic Office with original itemised receipts ([https://finance.admin.ox.ac.uk/claiming-expenses-departmental-guidance](https://finance.admin.ox.ac.uk/claiming-expenses-departmental-guidance)).

For courses without flights, alternative travel arrangements would be at the student’s own expense as we would still have the cost of the coach.

**Spain**

The field course to Spain is a broad-ranging introduction to the geology and tectonics of Almeria, south-east Spain. Fieldwork will be in the basins, mountains and coastal outcrops within about 60 km of the town of Carboneras. This region preserves a fabulous array of geology, mainly relating to the past 20-30 Ma, during which the Betic mountain range formed, collapsed and was then exhumed; a volcanic arc was active, and then burnt out; and a series of basins adjoining the Mediterranean sea formed, filled with clastic sediments and carbonates, and then dried out. This is a valuable synoptic field course - with something for everyone, irrespective of specialization - and it makes an interesting contrast to the second-year Dorset field course.

**Geodynamic model of the westernmost Mediterranean at the Miocene–Pliocene boundary** (Duggen et al., 2005).

Summary maps of Almeria showing (a) the general location, (b) the late Miocene paleogeography and (c) the regional geology (Montgomery et al., 2001).

**Background reading and preparation.**

Many of the field locations are introduced in Mather et al., (2001). There is also a rock and thin section collection associated with the course, which will form the basis of a pre-course practical exercise for familiarization.

**Field Guide**


Key introductory reading (papers all available in a box in the library and on ORLO).
Duggen S et al., 2003, Deep roots of the Messinian salinity crisis NATURE 422, pp 602-606
Duggen, S et al., 2005, Post-collisional transition from subduction- to intraplate-type magmatism in the westernmost Mediterranean: Evidence for continental-edge delamination of subcontinental lithosphere JOURNAL OF PETROLOGY 46, 1155-1201
Faccenna, C et al., 2004, Lateral slab deformation and the origin of the western Mediterranean arcs. Tectonics 23, TC1012.
Montgomery P et al 2001 Constraining controls on carbonate sequences with high-resolution chronostratigraphy: Upper Miocene, Cabo de Gata region, SE Spain PALAEOGEOGRAPHY PALAEOCLIMATOLOGY PALAEOECOLOGY 176: 11-45
Platt JP; Whitehouse MJ; Kelley SP; Carter A; Hollick L, 2003, Simultaneous extensional exhumation across the Alboran Basin: Implications for the causes of late orogenic extension GEOLOGY 31, pp 251-254

Online Reading List:
EARTH_MEarthSci_3rd year_Field Trip: Spain (Alemeria)
http://readinglists.bodleian.ox.ac.uk/lists/80D68686-37EC-6B53-A830-71468F24AD92

### 4th Year Field courses

Students will be consulted on the 4th year field course in Trinity Term. In previous years, they were asked to choose whether they wish to attend the Greece or Bermuda field course. Further information on both courses can be found in the 4th year section of this handbook. However, in 2020 the 4th year courses may change. We will notify 3rd year students of any developments, or if it is confirmed the Greece and Bermuda courses will repeat in 2020.

### Fourth Year Research Projects

In the 4th year, students carry out a research project under the supervision of a member of the Academic staff. The purpose of the project is to introduce students to scientific research first hand. In most cases, students work as part of a team on a topic that may involve laboratory work, computation, or fieldwork. The projects suggested include those of a geological, geochemical and geophysical nature, and may also be of a theoretical or an observational character. You are encouraged to suggest projects of your own based on your aptitudes and interests. Your suggested potential projects should be discussed with appropriate members of staff or your tutor at an early stage.

Students should start to give some thought to project areas and potential supervisors by the beginning of Hilary Term of 3rd year. Early in Hilary Term a member of the Faculty will give a brief introduction to the process of choosing a project, and the nature of project work (etc.), in a 1 hour timetabled presentation. All of this information will also be made available on WebLearn - including a listing of Faculty and the areas in which they offer projects. Reports of past projects can also be found in the library, and former students are also valuable sources of information about project areas and potential project supervisors. An updated list of possible projects suggested by staff should be available for circulation by Week 3 of Hilary Term.

The definition of a research project is first and foremost the responsibility of the student. Students should complete a weblearn questionnaire (which will be made available early in Hilary Term) to the on their project proposal(s) by the end of Week 7 of Hilary Term. All proposals should have been discussed with, and nominally approved by, the potential supervisor(s) - but this does not imply that the project will be approved by the Teaching Committee. Students should usually submit more than one choice, ranked in order of preference. Any students experiencing difficulty identifying project areas should discuss this with their college tutor at an early stage.

The Academic Administrator and Chair of Teaching Committee will then vet the proposals. They may also consult Teaching Committee. Projects will be allocated according to the students' preferences as far as possible, but subject to the proviso that no individual supervisor will have a load of more than 2 full projects (or equivalent). We will endeavour to inform students of their project allocation by the beginning of Trinity
Term. For most projects, this will leave plenty of time for planning and seeking financial support (e.g. for projects involving fieldwork).

Students who wish to use work completed on summer placements towards a project will be able to do so. In examples where summer placements are not firmed up until later in Hilary or Trinity terms, the students should nonetheless submit an application with as much detail as possible.

Decisions about what places are available are not made on a first come first served basis. Supervisors usually try to match aptitude, enthusiasm and specific ability to the projects proposed.

Project fieldwork

If you will be undertaking fieldwork in relation to your project, you or your supervisor must submit a risk assessment form to Stuart Robinson at least three weeks before departure. Once the form has been approved and signed you should submit it to the Academic Administration Office, and upload it with your travel insurance application (http://www.admin.ox.ac.uk/finance/insurance/travel/). Please discuss this with your supervisor and organise this with them well in advance of travel.
FOURTH YEAR COURSE

Deadlines

Please note:

1. Some of these dates are based on previous years, and may be subject to change. Every effort will be made to notify students of any changes as soon as possible. In the meantime PLEASE PUT THESE DATES IN YOUR DIARY NOW. You may not receive further reminders about some items.

2. These deadlines relate to departmental business, and you may have other important dates relating to college business.

3. Examination and some field course dates are in italics, as they will be confirmed nearer the time.

4. Deadlines in bold are included in the examination regulations or conventions and you may be penalised by the examiners if you do not meet them. ALL EXAMINATION MATERIAL SHOULD BE HANDED IN TO EMMA BROWN OR THE ADMINISTRATIVE OFFICER IN ROOM 10.33.

<table>
<thead>
<tr>
<th>TERM</th>
<th>WEEK</th>
<th>DAY</th>
<th>TIME</th>
<th>ITEM</th>
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<tbody>
<tr>
<td>Michaelmas Term</td>
<td>N/A</td>
<td>14-22 Sept</td>
<td>N/A</td>
<td>Bermuda field course</td>
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<tr>
<td></td>
<td>N/A</td>
<td>18-28 Sept</td>
<td>6.00am departure</td>
<td>Greece field course</td>
</tr>
<tr>
<td>Hilary Term</td>
<td>Week 1</td>
<td>Friday</td>
<td>12.00pm</td>
<td>Submit up to 8-page project progress report to supervisor</td>
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<tr>
<td></td>
<td>Week 7</td>
<td>N/A</td>
<td>N/A</td>
<td>Begin to organise 4th year mini conference</td>
</tr>
<tr>
<td>Trinity Term</td>
<td>Week 0</td>
<td>Friday</td>
<td>N/A</td>
<td>Submit first draft of 4th year project to supervisor</td>
</tr>
<tr>
<td></td>
<td>Week 1</td>
<td>TBA</td>
<td>TBA</td>
<td>4th year mini conference</td>
</tr>
<tr>
<td></td>
<td>Week 1</td>
<td>Friday</td>
<td>N/A</td>
<td>Supervisor to return draft project to student</td>
</tr>
<tr>
<td></td>
<td>Week 2</td>
<td>Thursday</td>
<td>2.00pm</td>
<td>Hand in 3 copies and pdf of 4th year project to Emma Brown in room 10.33</td>
</tr>
<tr>
<td></td>
<td>Week 3/4/5/6</td>
<td>Date TBA</td>
<td>Time TBA</td>
<td>Project viva with project markers</td>
</tr>
<tr>
<td></td>
<td>Week 7</td>
<td>Dates TBA</td>
<td>Times TBA</td>
<td>Part B examinations</td>
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<td>Week 9</td>
<td>TBC</td>
<td>TBA</td>
<td>Vivas with External Examiner</td>
</tr>
<tr>
<td></td>
<td>Week 9</td>
<td>Friday</td>
<td>4pm</td>
<td>Finals Party</td>
</tr>
</tbody>
</table>

Fourth Year Research Projects

In the 4th year, students carry out a research project under the supervision of a member of the Academic staff. The purpose of the project is to introduce students to scientific research first hand. In most cases, students work as part of a team on a topic that may involve laboratory work, computation, or fieldwork. You should already have been allocated a project and supervisor before the end of your 3rd year.

Responsibility for the project lies with the student; and you should be proactive in seeking support and guidance as you complete your project. If you experience any problems with your project at any point, please ensure you discuss this with somebody as soon as possible. If you feel unable to approach your supervisor, please contact your tutor, the Undergraduate Advisor, or one of the academic administration team.

Information about submitting your project is available in the appendices.
Supervision and training

Students should expect to have regular contact with their supervisor(s) over the course of the project, with more intensive support being usual in the initial and final stages of the project. Usually this will be a minimum of an hour per week during Michaelmas and Hilary Terms, or eight hours per term for both terms. Students should discuss the pattern of project supervision with their supervisor(s) at an early stage of the project. The support given by supervisors in meetings, or by email, may include formal discussion of research, feedback on the student’s writing, analysis of results and direction to the relevant literature, as well as discussions of anything else needed for the investigations to progress smoothly. Further support will be given in the techniques required for the student to carry out their research including, for example, training in software, use of equipment, and so on. Students should note that (i) it is in the nature of research that not all projects will require the same type or level of support and (ii) for some projects the supervisor will personally deliver specialist training, whilst for others training and advice may be provided by technical staff, or researchers associated with the research area. Students should also note that access to and use of departmental facilities (e.g. the SEM, etc.) will often require advance booking, and discussion with the appropriate technical or research staff. Students are encouraged to discuss their likely requirements with their supervisors, and plan their work accordingly.

Students should submit an 8-page progress report to their supervisor by Friday of Week 1 in Hilary Term. This is an informal process, and is not examinable. The aim is to provide an additional opportunity for feedback whilst the project is still in progress.

Formal supervision of the project ends at the end of week 0 of Trinity Term, with the submission of the draft project to the lead supervisor. After this point, the only feedback on the project will be the one-page review by the supervisor; it is the responsibility of the student to complete the final revisions to the project.

Project fieldwork

If you will be undertaking fieldwork in relation to your project, you or your supervisor must submit a risk assessment form to Stuart Robinson at least three weeks before departure. Once the form has been approved and signed you should submit it to the Academic Administration Office and upload it with your travel insurance application (http://www.admin.ox.ac.uk/finance/insurance/travel/). Please discuss this with your supervisor and organise this with them well in advance of travel.

Tutorials

There are no formal tutorials in year four, where instead you will receive close project supervision from one or more project supervisors.

Examinations

Please see Appendix 1: Examining Conventions.
**COURSE STRUCTURE**

4th year, 2019-20

Each student takes 4 papers, plus 4th year project.

<table>
<thead>
<tr>
<th>Michaelmas Term</th>
<th>Hilary Term</th>
<th>Trinity Term Revision</th>
</tr>
</thead>
</table>
| **Paper 5 (A10822W1)**  
Rock & Palaeomagnetism  
CM 16 |  
**Paper 2 (A10819W1)**  
Planetary Chemistry  
CB/JW/NT 16 |  |
| **Paper 7 (A10817W1)**  
Topics in Volcanology  
DMP/TM 16 |  
**Paper 6 (A10823W1)**  
Anatomy of a Mountain Belt  
MPS 16 |  |
| **Paper 8 (A10824W1)**  
Topics in Oceanography  
RR/HB/SK/HLJ 16 |  
**Paper 1 (A10818W1)**  
Palaeobiology  
ES/RB 16 |  |
| **Paper 4 (A10821W1)**  
Major Environmental Change  
RR/SR/NT 16 |  
**Paper 3 (A14758W1)**  
Structure & Dynamics of the Earth’s Mantle  
KS/RK/HK 16 |  |

Fieldtrips:  
Greece/Bermuda

Note: 4th year courses are mostly seminar-style
Fourth Year Course Synopses and Reading Lists

Books used in each lecture course may be ranked as: Essential (***); Useful (**); Supplementary (*). Numbers in bold type indicate the shelf-mark of each book. There should be a reference copy of each title in the “Confined Cupboard”. Loan copies will also usually be available and will have the same shelf location. (Check the online catalogue – OLIS – for copies in other libraries). Remember that it is easy to recall books that are out on loan by emailing the librarian. Further reading (e.g. research papers) will be provided in lectures.

Details of all courses, including reading lists and lecturers, may be subject to change by individual instructors.

Prerequisites for 4th year options

4th year options have the following prerequisites:

Paper 1: Palaeobiology - it is **recommended** students take the 3rd year *Vertebrate Palaeobiology* option, but students who wish to take the 4th year option will be considered on a case by case basis.


Paper 3: Structure & Dynamics of the Earth’s Mantle - it is **recommended** that students take *Geodynamics and Continental Deformation* in the 3rd year, but reading can be suggested if they have not.

Paper 4: Major Environmental Change - none.


Paper 6: Anatomy of a Mountain Belt - it is **useful but not essential** for students to take the 3rd year *Earth Materials and Continental Deformation* options.

Paper 7: Topics in Volcanology - it is **recommended** that students take the 3rd year *Volcanology* option, but reading can be suggested if they have not.

Paper 8: Topics in Oceanography - it is **recommended** that students take the 3rd year *Biological & Physical Oceanography* option, but reading can be suggested if they have not.

Paper 1: Palaeobiology

Prof E Saupe & Prof R Benson

Topics will address major current debates and controversies in the fields of Palaeobiology and Evolution. Topics include: How reliable is the fossil record? Major evolutionary radiations. Biodiversity through time. Animal origins and the Cambrian Explosion. Dinosaur palaeobiology, evolution and the origin of birds. Hominid origins and evolution. Neanderthals and the origin of anatomically modern humans. The order and selection of these topics may vary.

Suggested Texts:


Online Reading List:

EARTH_MEarthSci_4th year_Paper 1: Palaeobiology
**Paper 2: Planetary Chemistry**

Prof C Ballentine, Prof N Tosca & Dr J Wade

The course will examine, through a mixture of lectures, group discussions and student presentations, the processes involved in solar system formation and the establishment of the large-scale chemistry of the Earth. Topics will include solar nebula condensation, growth of planets, timing of Earth formation and segregation of the core, evolution of Mars, formation of the moon, redox state of the Earth, and the distribution of water within the Earth.

**Online Reading List:**
EARTH_MEarthSci_4th year_Paper 2: Planetary Chemistry
http://readinglists.bodleian.ox.ac.uk/lists/EC5B61A7-2EC6-2DF4-A3B7-529D5268B53B

**Paper 3: Structure & Dynamics of the Earth's Mantle**

Prof K Sigloch, Prof R Katz & Prof H Marquardt

The course is primarily designed to address the question, "How does plate tectonics arise from the dynamics and material properties of the upper mantle?". Topics to be covered include: forces giving rise to plate motions; the basic material requirements of plate tectonics; the transition between brittle fracture and ductile flow; the asthenosphere; mid-ocean ridge processes; subduction-zone processes; and the fate of subducted slabs. This multidisciplinary course is organized around student presentations and discussions of chosen papers, as well as brief introductory or background material presented by the lecturers.

**Online Reading List:**
EARTH_MEarthSci_4th year_Paper 3: Structure and Dynamics of the Earth's Mantle
http://readinglists.bodleian.ox.ac.uk/lists/CBD139C9-5725-0F79-8E73-FDC23AC059FD

**Paper 4: Major Environmental Change**

Prof R Rickaby, Prof S Robinson & Prof N Tosca

This option considers the nature and causes of major perturbations and transitions in the Earth's environmental systems. The course is run principally as a seminar series in which all students will have an opportunity to discuss key papers on particular topics, often a single major event. Typical topics covered include oxygenation, glaciations, anoxia, hyperthermal events, and the Anthropocene.

**Suggested Texts:**
Huber et al. (eds). (2000) Warm Climates in Earth History - 4C.29 **

**Online Reading List:**
EARTH_MEarthSci_4th year_Paper 4: Major Environmental Change
http://readinglists.bodleian.ox.ac.uk/lists/DC4B9E54-1267-8F04-F035-39F683828ED6

**Paper 5: Rock and Palaeo-magnetism**

Prof C MacNiocaill

The magnetic record in rocks and minerals carries information that can be used to study problems in a very diverse range of geological, environmental and archaeological fields. This course will cover the fundamental physics that underpins the technique, and will use case studies to illustrate the application of the technique. These may include:- the dynamics of Earth’s magnetic field; the fundamentals of rock
and mineral magnetism; studies of climate change through magnetic properties of sediments and soils; the emplacement temperatures and transport dynamics of pyroclastic flows; aspects of continental deformation and terrane migration; and plate motions, the fixity of hotspots and geodynamic reference frames.

**Suggested Texts:**
- Butler, R.F. (1992) *Paleomagnetism* (particularly chapters 2, 3 & 8 (pp. 187-203) available online at course website) - **2A.122**

**Online Reading List:**
- EARTH_MEarthSci_4th Year_Paper 5: Rock and Palaeomagnetism
  [http://readinglists.bodleian.ox.ac.uk/lists/54C0B2D6-696A-1488-4F8F-D44DC4C74CAE](http://readinglists.bodleian.ox.ac.uk/lists/54C0B2D6-696A-1488-4F8F-D44DC4C74CAE)

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**Paper 6: Anatomy of a Mountain Belt**

*Prof MP Searle*

This course will cover long-term, geological processes involved in the creation of mountain belts, mainly along the Alpine - Himalayan chain. Continent - ocean (or island arc) collision zones as exemplified by the Oman Ophiolite, early continent - continent collision, as exemplified by the Zagros ranges, Iran, and later continental collision, as exemplified by the Himalaya and Tibetan plateau will be used as the main examples. Processes discussed will include: ophiolite origin and emplacement, mantle - crust processes in oceans and ophiolites, deep subduction of continental crust, crustal shortening and thickening processes, development of oil and gas traps in thrust belt forelands and flexural foreland basin development. The course will also cover deeper crustal processes during collision, including: inverted metamorphism, crustal melting and granite emplacement, thrust and normal faulting in compressional mountain belts, middle - lower crustal flow in the Himalaya and Eastern Tibet. Mechanisms of formation and uplift of the Tibetan Plateau will include discussions on the role of continental extrusion and large-scale strike-slip faulting (e.g.: Karakoram, Altyt Tagh, Red River faults), and the role of crustal thickening and timing of surface uplift. The course will consist of 8 weeks of lectures, practicals and a final seminar series in which students will present talks on a specific aspect of the course, or based on recent research papers.

**Online Reading List:**
- EARTH_MEarthSci_4th year_Paper 6: Anatomy of a Mountain Belt
  [http://readinglists.bodleian.ox.ac.uk/lists/D8356EF3-8D59-9194-6ADC-578F4C3D8D3A](http://readinglists.bodleian.ox.ac.uk/lists/D8356EF3-8D59-9194-6ADC-578F4C3D8D3A)

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**Paper 7: Topics in Volcanology**

*Prof D Pyle & Prof T Mather*

**General themes and outcomes**

This course will focus on a range of current problems in volcanology, through a series of eight 2-hour seminars. The first 2-hour session will provide an introduction to the course, and will cover some introductory material. For each of the following weeks we shall pose a question, which will set the theme for the papers under discussion. Everyone attending the course will be expected to read 4-6 papers each week. The first paper or papers will be either recent review or overview papers, or some that present the “current” consensus view. The other three papers will present more specific view points on the subject and will be the focus of the student-led seminars and discussion. Topics that we shall cover will include the atmospheric and environmental impacts of volcanic emissions and hazard, risk and predictability of eruptions.

**Lecture-by-lecture outline**

These vary from year to year as we aim to keep the course refreshed with current topics.

**Practicals and techniques learned/used**

Specific skills acquired/revised will include:

- High-level familiarity with the cutting edge of volcanological research
• Critical reading of the current scientific literature
• Developing question asking skills
• Presentation skills

Exam descriptor
Usually multi-part questions based on data interpretation and/or answering a high-level question using the literature assimilated by the student over the course.

Online Reading List:
EARTH_MEarthSci_4th year_Paper 7: Topics in Volcanology
http://readinglists.bodleian.ox.ac.uk/lists/B46185F6-B4AF-9751-67B0-80986EF2140C

Paper 8: Topics in Oceanography

Prof H Johnson, Prof R Rickaby, Prof H Bouman & Prof S Khatiwala

8 x 2-hour seminars

In a series of eight two-hour student-led seminars, this course will cover hot research areas in oceanography: subjects where rapid advances are being made, or important problems are being identified. The topics selected will span diverse aspects of oceanography including biology, chemistry, physics, and the intersections between these subjects. Each topic will be introduced briefly by a faculty member, and then covered by a number of student presentations based on set reading and practical exercises. Examples of subjects covered in recent years include:

• Ocean de-oxygenation
• Role of trace metals in the carbon cycle
• Ocean acidification
• Sea-level
• AMOC and its role in the climate system

Online Reading List:
EARTH_MEarthSci_4th year_Paper 8: Topics in Oceanography
http://readinglists.bodleian.ox.ac.uk/lists/69F0C69A-3C4F-2CC1-35C0-EC17289CCB

FIELD COURSES

Health Issues
If students have any health issues that may affect their participation in a field course, they will be asked to provide a letter from their GP confirming that they are fit to participate in the various aspects of the course (a list of specific points for your GP to respond to will be provided). It is the responsibility of the student to ensure that the field course leader and academic administration staff are aware of their health issues. The student should ensure they discuss with them how their health issues might affect participation in the field course and any special requirements that need to be addressed, in good time before the field course.

Alternative Travel Arrangements
We encourage students to travel with the main group as much as is practicable.

Students who do not intend to travel as part of the main group for field courses, must inform the Academic Office as soon as possible. Students must make their own arrangements to and from an agreed location (such as the airport or accommodation), and they must work around the timings for the group, for example, if the course includes a flight, the student must arrive before or at the same time as the group so as not to cause a delay, and on the return they must depart at the same time or later than the group.

For courses with flights, students can be reimbursed for their alternative travel arrangements up to the cost of the flights per person on the group booking, minus any cost that the department may have already paid and cannot reclaim. An Expenses Claim form must be completed, signed, and submitted to
For courses without flights, alternative travel arrangements would be at the student’s own expense as we would still have the cost of the coach.

### Bermuda

This course focuses on oceanography (physical, chemical, and biological); and on carbonate environments (marine, terrestrial, and karstic).

The course is hosted at the Bermuda Institute for Ocean Sciences and runs for eight days including travel. Activities include:

i. an overnight excursion on an ocean-going research vessel to experience field-based oceanography in the open Atlantic. This introduces use of CTD and sampling equipment to assess subsurface conditions and investigates the circulation and chemistry of surface and deep-water masses including NADW. The ecosystem of the North Atlantic Gyre is also investigated and samples returned to the labs in BIOS to study species and function.

ii. Excursions on a smaller vessel to areas of the Bermuda coast where the reef environment can be observed from the boat and whilst in the water. These excursions assess both the biological ecosystem, and the production of sediment in a carbonate platform environment. Another excursion assesses the lower oxygen environments of a lagoonal setting. Evening exercises involve training in the use of the very widely used Ocean Data View software, and investigation of the impressive time series of ocean data from offshore Bermuda to provide context to the observations made in the field.

iii. The carbonate sedimentology of the island is studied during a day excursion around the island, investigating the sequence of dunes and soils that accumulate in response to climate and sea-level change during the Pleistocene.

iv. Observations in one of the many caves on Bermuda consider the formation of such karstic features, the development of speleothems, and their use as sealevel and paleoclimate archives.

This course will use and build upon material in the climate, oceanography, sedimentology, and palaeobiology aspects of the undergraduate course.

### Greece

This course is a pre-sessional and optional course for a limited number of students.

The Greek field course is mainly concerned with active geological processes, providing several aspects of training not otherwise available in the field programme. One aim is to demonstrate the importance of an integrated geological study that makes use of geophysical and geochemical data, and evidence from sediments and fossils, to build up a picture of active deformation of the continental crust. The course focuses on two related investigations:

1. An active volcano, Santorini, in the Aegean Sea.
2. Active faulting and its effect on sedimentation in the Gulf of Evvia and Gulf of Corinth regions.
The island of Nea Kameni - the site of active volcanism in the centre of the present Santorini caldera. This island is visited by boat during the field course in order to see very recently erupted volcanics, and ongoing hydrothermal activity.

Days 1 to 3 are spent on Santorini, examining the great variety of eruptive rock types and the details of the volcanic sequences related to major eruptions. Evening exercises include using field data to calculate the duration and volume flux of the Minoan eruption. We also see the destructive power of the eruption at the Minoan excavations in Akrotiri.

The Minoan deposits at Oia. The Minoan eruption deposited up to 10 metres of volcanic deposits, initially as air-fall, but then as hot pyroclastic flows, about 3600 years ago. This eruption entirely wiped out civilization on the island, and may well have played a significant role in the collapse of the Minoan civilization centred on Crete.
Days 4 to 10 are spent on the mainland of Central Greece. We begin in the Locris area, at the north end of the Gulf of Evvia. We learn about the pattern of faulting related to extension of the crust, its control on sedimentation, and the sequence of faulting through time, by observing features of the landscape around Kamena Vourla, Kalliromon, and Parnassos. We then move South to the Gulf of Corinth, stopping on the way to visit the active faulting near Thebes, including the 1981 Plataea-Kaparelli fault scarps. The Gulf of Corinth preserves a variety of sediments deposited during its evolution, and in particular reveals the interplay between movements of the crust and sea-level change.

**Suggested Texts:**
- Cas & Wright (1988) Volcanic Successions - Modern and Ancient. - 26E.92 ***
- Sparks et al. (1997) Volcanic Plumes - 26E.91 (Confined Cupboard only) (Out of print) **

*At the fault face. This large fault surface in limestone, at Arkitsa, close to the south coast of the northern Gulf of Evvia, was revealed when scree covering it was excavated for use in road construction. The fault surface shows prominent striations and corrugations, the orientation of which show an oblique sense of movement associated with the rotation of crustal blocks necessary to accommodate the overall deformation in the region. There is a discoloured band between the excavated fault surface and the vegetation above, which may represent the slip that occurred in the most recent earthquake.*
Appendix 1 - EXAMINING CONVENTIONS

Introduction

Examination conventions are the formal record of the specific assessment standards for the course or courses to which they apply. They set out how examined work will be marked and how the resulting marks will be used to arrive at a final result and classification of an award.

These conventions apply to the 3-year BA in Geology and 4-year MEarthSc in Earth Sciences for the academic year 2018-9. The Departmental Committee of the Department of Earth Sciences is responsible for approving the conventions.

The degree course is divided officially into two sections with a hurdle at the end of the first year. This test, the Preliminary Examination in Earth Sciences (otherwise known as the First Public Examination - or Prelims) must be passed in order to proceed to the Final Honour School (usually shortened to ‘Finals’) that is examined in years 2, 3 and 4.

PLEASE ALSO REFER TO THE EXAMINATION REGULATIONS FOR THE CURRENT ACADEMIC YEAR.

You can find them online at:

http://www.admin.ox.ac.uk/examregs/

Examination Entry

This is co-ordinated by the Examination Schools. For details, please see:

http://www.ox.ac.uk/students/academic/exams

www.ox.ac.uk/students/academic/exams/timetables

Past Papers and Exam Reports

These are available on the department’s weblearn site at:

https://weblearn.ox.ac.uk/portal/hierarchy/mpls/earth/ugrad/page/examinations

Exam reports for the previous academic year are made available to students once they have been approved by the appropriate departmental and University committees. It is usually possible to publish internal reports by the end of Michaelmas Term and external reports (plus departmental response) by the end of Hilary Term.

Ongoing Feedback

Work completed for practicals or fieldwork exercises may be assigned a mark. These marks do not aggregate to your degree result, but you should treat them as important indicators of the quality of your work. In addition, tutorial work will also commonly be assessed and your college will take a keen interest in the standards you achieve. Again, these marks do not contribute to your degree classification, but they do provide valuable feedback to you on your understanding of the material of the course.

Note that, although they will not make use of the marks for field and practical courses, Finals examiners may take into account completion and standards achieved when they set the borderlines between classes of degree.
Students are also provided a wide range of informal feedback in tutorials and in discussions with instructors in classes, practicals, and on field courses.

### Examining Procedures

#### University Cards
Candidates must bring their university cards with them.

#### Candidate numbers
Please ensure you have your candidate number with you (NOTE: this is not the same as your student number). You can locate your candidate number on the Examination and Assessment Information page in Student Self Service or by looking on the top of your individual examination timetable.

#### Dress for Examinations
In all years, Academic Dress (sub-fusc) must be worn for all examinations, including the practicals and any interviews with external examiners.

#### Procedure after Examinations
All candidates are reminded of the Proctors’ regulations that they should leave the area of the Examination Schools, Ewert House or the Department of Earth Sciences, whichever is applicable, as soon as the papers are ended and not celebrate near the Schools, Ewert House or the department. Candidates should leave the area quietly, in order not to disturb any candidates with extra time still in examinations.

“Trashing” is prohibited by university regulations:

[https://www.ox.ac.uk/students/academic/exams/behaviour-after-exams?wssl=1](https://www.ox.ac.uk/students/academic/exams/behaviour-after-exams?wssl=1)

#### Calculators, books, etc. in Examinations

##### Calculators

1. No calculator for which a mains supply is essential will be allowed. It is the responsibility of the candidate to ensure that the power supply of the calculator is adequately charged.
2. Any calculator deemed by the Proctors or the Examiners to cause a disturbance will not be allowed.
3. Output from a calculator shall be by visible display only.
4. Candidates are required to clear any user-entered data or programmes from the memories of their calculators immediately before starting each examination.
5. No storage media external to the calculator are permitted.
6. Input to the calculator during the examination shall be by its own keys or switches only.
7. The examiners may inspect any calculator during the course of the examination.

##### Books, notes. etc. in Examinations

No books or papers of any sort may be brought into the examinations.

Scrap paper will not be provided in exams. Preliminary calculations, notes, etc. must be written in the answer books and should be scored through to indicate that it is not intended for consideration by the examiners as part of the completed answer.

##### Mobile phones

Mobile phones will not be permitted in the department on the days during which practical examinations are in progress. Candidates must leave them at home, or deposit them with an invigilator for safe keeping. If you are found with a mobile phone in the examination, this breach of regulations may be reported to the proctors and lead to a reduction in grade or outright failure of the examination.

##### Microscopes

Please note the following for the 1st and 2nd year practical components: candidates should report any microscopes that are not in good working order to Owen Green:

Owen.Green@earth.ox.ac.uk

##### Equipment

Candidates must bring all the usual equipment for a practical (pencils, coloured pencils, ruler, protractor, rubber, pens, hand lens etc.)
Please note that candidates should not communicate directly with the examiners or the examinations secretary regarding the examinations. In the first instance, candidates should contact their college tutor with any queries or concerns.

Information on (a) the standards of conduct expected in examinations and (b) what to do if you would like examiners to be aware of any factors that may have affected your performance before or during an examination (such as illness, accident or bereavement) are available on the Oxford Students website:

www.ox.ac.uk/students/academic/exams/guidance

IN TRINITY TERM STUDENTS SHOULD ENSURE THEY REMAIN IN OXFORD UNTIL THE END OF FULL TERM, OR THE END OF WEEK NINE FOR FOURTH YEAR STUDENTS.

Prelims

The results of the Preliminary Examination are not classified (into 1st, 2nd class etc.), but candidates are required to pass every paper if they are to continue into the Second Year. Candidates who do not pass a Prelims paper at the first attempt will have to re-sit, and pass, that paper in September. Candidates who fail three or more papers at the first attempt will have to resit, and pass, all Prelims papers in September. The top candidates may be awarded a Distinction, and outstanding performance may also lead to an award from the student’s college.

Finals

The marks of the 2nd year Part A1 examinations contribute to the final Part A mark at the end of 3rd year. Part A results are nominally classified. Candidates are required to achieve at least a nominal 2.2 to proceed to Part B. Candidates who achieve lower than a nominal 2.2 will be awarded the BA in Geology. Candidates who fail Part A may resit once the following year, but may not proceed to 4th year and will be awarded the BA in Geology. Candidates who withdraw from 4th year and do not plan to return will be awarded the BA in Geology.

Examiners

Each year, the Departmental Committee of the Department of Earth Sciences elects three Prelims Examiners and three Finals Examiners from among the academic staff of the department. Usually internal examiners will serve for three years. In addition, the Departmental Committee nominates two External Examiners - one for Part A and one for Part B. Usually, the Part A External Examiner for one year becomes the Part B External Examiner for the same cohort of students in the following year. The External Examiners have two principal roles. The first is, under guidelines imposed nationally and by the University, to report on the standards of the examinations and the procedures under which they are carried out. The second role is to act as moderators and arbitrators within the examination procedures.

For 2019-20, the External Examiners are as follows:

Part A - TBC
Part B - Professor Rachael James, National Oceanography Centre

Assessors

All eligible senior members of the staff of the Department of Earth Sciences who have taught courses to the candidates are invited to become Assessors for Parts A and B of the Final examination. Assessors may set and mark questions and papers, but they play no part in the final aggregation of marks and classification of degree results.

Queries, Concerns and Factors Affecting Performance

If you have a legitimate reason you are unable to hand in your coursework on time, are sick, or have other extenuating circumstance that might affect your examination performance you should contact your Tutor and College Office as soon as you become aware of this. They will submit your case to the Proctors for assessment.
Similarly, if any kind of extenuating circumstance arose during your examinations, you should contact your Tutor and College office, and consider formally submitting a Factors Affecting Performance case following your examinations.

You should not contact the Examiners or the Academic Administrator.

Penalties

Deadlines

Students should ensure they plan ahead to hand in their work before the published deadline. If examination material is handed in after the deadline, the work will be marked as usual but the following penalties will be applied:

- up to 24 hours 5%
- 24-48 hours 10%
- 48-72 hours 20%
- 72-96 hours 30%
- 96-120 hours 40%
- 120 hours-14 days 50%
- Over 14 days Fail

Note that the cumulative penalties will be deducted from the mark (when expressed out of 100%) as percentage points, but the overall mark cannot go below 10%. For example, if a student hands in a piece of work 20 hours late, and that work in itself is worth 65%, the tariff indicates a deduction of 5% leading to a final mark of 60%.

This penalty may be reduced or waived, in particular when, in view of exceptional circumstances, the Proctors have given prior permission for late submission. Therefore if special factors make it likely that you will not make a deadline, you should ensure that well before the deadline you contact your Tutor and College Office.

Note that non-submission of a required assessment for Final Honour School will result in an overall Fail for the whole Final Honour School.

Declaration of Authorship

The project or essay must be the student’s own work, and a declaration to that effect must be written and signed at the front of the document that is handed in. You can download the University declaration form on Weblearn here:

https://weblearn.ox.ac.uk/portal/site/%3Amps%3Aearth%3Augrad/page/be03fa79-51a8-4152-a8b3-fc4b5be567a6

Word Count

Students must also declare the word count at the front of the document. If it is suspected a piece of work is over the declared word count, the student will be requested to hand in an electronic copy of the work. The word count will be confirmed, and the electronic copy will be checked against the hard copy to ensure they are identical. If a student is over the word count, marking will cease once the word count has been reached.

Examination paper rubric

Where a candidate has failed to answer a compulsory question, or failed to answer the required number of questions in different sections, the complete script will be marked and the issue flagged. The board of examiners will consider all such cases so that consistent penalties are applied. A mark of zero shall be awarded for any part or parts of questions that have not been answered by a candidate, but which should have been answered. Where a candidate has answered too many questions from an examination paper or section of a paper, answers with the lowest marks will be excluded, until the requisite number of answers is reached.

Descriptors for Marking

Each answer to a question in written and practical papers is allocated a mark in the range 0-100, according to the Marking Descriptors given in Appendix 1. The marks for each answer are added to give a total for
each paper, except that if more than the specified number of questions is answered, answers with the lowest marks will be excluded, until the requisite number of answers is reached.

Mapping Reports, 3rd-Year Essays and 4th-Year dissertations are allocated marks in the range 0-100, according to relevant class descriptors, provided on page 75.

Marking Procedure

All scripts are double-marked “blind”, and assessors will not be made aware of any late submission. Each assessor has the model answer, but neither assessor has knowledge of the mark assigned by the other. Assessors do not write on scripts during the marking process, except to indicate objective errors, e.g. in a calculation. Where a significant discrepancy (i.e. over 10%) occurs between the two marks, either the script is returned to the assessors to agree a mark jointly, or the script is moderated by the examiners. The same procedure is applied to essay assignments and projects. The fourth-year project is double marked by two internal assessors and moderated by the Examiners. The mapping project is double marked internally and is moderated by the Examiners.

Results

Results are usually finalised and available to students around the following times:

- **1st Year Prelims** - Monday of Week 10 in Trinity Term
- **2nd Year Part A1** - Monday of Week 11 in Trinity Term (in the Long Vacation)
- **3rd Year Part A2** - Friday of Week 7 in Trinity Term
- **4th Year Part B** - Thursday of Week 9 in Trinity Term

It cannot be guaranteed results will be available at these times, but we will keep students informed of any delays.

Interviews with External Examiners

The External Examiners will be present at, and contribute to, the Final Examiners’ meetings at which marks and classifications are confirmed and finalised, for the Part (A or B) to which they are appointed.

In pursuance of their roles, as outlined below (Role of External Examiners), the External Examiner for Part B will interview Part B students for the purposes of supplementary assessment.

Degree classification

The marks for each unit of assessment (Exam Paper, Mapping Report, Essay, and Dissertation) will be given the relative weights shown in the Table in Appendix 1. The aggregate mark will be expressed as a percentage to be used in assigning the degree classification.

Because of the small class size, no re-normalization of the marks will be carried out to account for unexpectedly low or high average marks in individual papers. However, the Examiners monitor the distribution of marks assigned for each paper to ensure, among other considerations, that there is a fair balance between the optional sections of Part A, and between the different papers in Part B, and to ensure that no candidate is disadvantaged purely as a result of their choice of topic.

The boundaries between degree classes will follow closely the University conventions shown in the table below, but will not lie exactly on the class divisions shown in the table. In defining class boundaries, the Examiners will take into account the distribution of candidates’ marks over the papers, together with submitted practical materials and assessments by the External Examiner which will, in Part B, be informed by interviews with the candidates.

<table>
<thead>
<tr>
<th>Degree Classification</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Class</td>
<td>70 and above</td>
</tr>
<tr>
<td>Upper Second</td>
<td>60 to 69</td>
</tr>
<tr>
<td>Lower Second</td>
<td>50 to 59</td>
</tr>
<tr>
<td>Third</td>
<td>40 to 49</td>
</tr>
</tbody>
</table>
Students graduating at the end of their third year will be awarded a classified degree based on their Part A marks, as described above. (Note that that these candidates will not be interviewed by the External Examiner for the purpose of assessing their performance.) Students who intend to proceed to the MEarthSci will not be awarded a degree classification; their marks will be carried over for use in the classification procedure in combination with their Part B marks, at the end of their fourth year. In the case of a student who leaves after taking Part A exams, but before completing Part B, the Examiners will revisit the student’s Part A marks, and will assign a degree classification following the procedure outlined in this appendix.

Role of External Examiners

External examiners will be used primarily for the purposes of moderation and arbitration.

National guidance requires external examiners to report on three major areas:

(i) whether the standards set are appropriate for the award;
(ii) the standards and comparability of student performance in the programme;
(iii) the extent to which procedures for assessment, examination and the determination of awards are sound and have been fairly conducted.

The department will allow external examiners to:

(a) have opportunity to comment on all examination papers in draft form;
(b) have access to all scripts and other material submitted by candidates;
(c) see a sample of scripts including scripts at the borderlines of classes;
(d) see a sufficient sample of dissertations, extended essays and course work to be able to comment on the marks awarded;
(e) be in a position to comment on the fairness of any procedures for the reconciliation of marks, moderation, scaling and adjustments arising out of medical or other evidence.

In relation to (e), the University does not regard this as requiring the external examiner to give a definitive final mark where there is initial disagreement between first markers (although examining boards may choose to ask the external examiner(s) to act in this way) but to be in a position to report on the soundness of the procedures used to reach a final agreed mark.

The Honours School of Earth Sciences appoints a Part A External Examiner each year, and this examiner’s duties continue the following year when they become Part B External Examiner for the same cohort of students. In addition to previewing papers, the department will also send the mapping projects to the Part A external examiner following internal marking, for the purposes of independently considering the projects before seeing internal marks. The department will also send the 4th year projects to the Part B external examiner, for the purposes of providing a suggested nominal mark to compare to the two internal marks.

The external examiners will have the opportunity to interview students for the purposes of supplementary assessment (following Part B). They will be present at, and contribute to, the final examiners meetings where marks and classifications are confirmed and finalised.

Preliminary Examination

These usually take place in Week 7 of Trinity Term. You will sit the following 3 hour compulsory examination papers:

- Physics, Chemistry & Biology for Earth Sciences
  (Candidates must answer four questions in total; at least one from each section and exactly one from Section C. There are three sections.)
- Planet Earth
  (Candidates must answer four questions in total; at least one from each section and exactly one from Section C. There are three sections.)
- Fundamentals of Geology (Theory)
  (Candidates should answer two questions from Section A and two questions from Section B.)
Second Year Examination, (BA Geology; MEarthSc Part A1)

The 2nd year examination consists of three papers: two written papers and one practical paper. The practical paper will be held in the Department of Earth Sciences and the written papers in the Examination Schools, probably in Week 6 of Trinity Term (to be confirmed). The paper structure will be similar to the following:

Paper 1:
Section A: Earthquakes & Faulting (30 mins)
Section B: Remote Sensing & Active Tectonics (30 mins)
Section C: Geophysical Methods (30 mins)
Section D: Thermodynamics (30 mins)
Section E: Mathematical Tools 1 (30 mins)
Section F: Evolution (30 mins)

On Paper 1, candidates should answer one question from each section. Each section will have two questions.

Paper 2:
Section A: Sedimentary Geology: Sedimentary and Diagenetic Processes (60 mins)
Section B: Sedimentary Geology: Environments & Stratigraphy (30 mins)
Section C: Igneous and Metamorphic Petrology (30 mins)
Section D: Carbon Cycle (30 mins)
Section E: Isotope Geology (30 mins)

On Paper 2, candidates should answer two questions from Section A and one question from each of Section B, C, D and E. Section A will have four questions, and Sections B to E will have two questions.

Paper 3 (Practical):
Section A: Geological/Structural Map Interpretation (1 hour)
Section B: Igneous and Metamorphic Petrology (1 hour)
Section C: Sedimentary Rocks (1 hour)

On Paper 3, candidates should answer all questions (one in each section).

For Paper 3 candidates will be split into two groups; one group to sit in the morning and one in the afternoon, and one group will be held 12.30-1.30. Detailed arrangements will be notified closer to the time.

Third Year Examination (BA Geology; MEarthSc Part A2)

The third year course will allow a degree of specialization within Earth Sciences sub-disciplines, and at the same time will continue to develop core skills and knowledge. There are also two substantial pieces of formally assessed independent work - a literature review and a field-mapping project.

Subject matter will be grouped into options. Students choose six options overall across Michaelmas and Hilary Term. In addition the Spanish Field course and associated short lecture course will be compulsory. Options will be timetabled in either Michaelmas Term or Hilary Term to allow students to pursue a programme of study that covers a coherent grouping of subjects.

The third-year (Part A) examination consists of seven written papers (six out of nine options plus fieldwork paper) and two pieces of independent work. In addition, marks from the second-year examinations are carried forward. Entry to the Part A examination is handled through the colleges.

Examinations

The examinations will probably be scheduled for Weeks 4-5 of Trinity Term (dates to be confirmed, and possibly running into week 6). All papers will be sat in the Examination Schools. Further details of the topics to be examined in each paper are published by the Finals Examiners during the year.

You will sit six out of nine optional papers:
Undergraduate Handbook 2019-20 v1.3

Paper 1 - Sedimentary Basins
Paper 2 - Natural Resources
Paper 3 - Biological & Physical Oceanography
Paper 4 - Climate
Paper 5 - Seismology & Earth Structure/Vector Calculus
Paper 6 - Volcanology, Igneous Processes & Petrogenesis
Paper 7 - Vertebrate Palaeobiology
Paper 8 - Earth Materials, Rock Deformation & Metamorphism
Paper 9 - Geodynamics

Plus the compulsory paper:

Paper 10 - Fieldwork & Interdisciplinary

For Papers 1-9 candidates answer two out of three questions. For Paper 10 they answer two out of five questions.

Submission of Practical Materials
Candidates in Part A may be required to submit their practical notes and field notebooks relating to courses undertaken in the second and third years of study for consultation by the examiners. If the examiners wish to see this material they will request it during Wednesday to Friday of week 7 of Trinity Term.

Publication of Results
Public lists of exam results are no longer formally published by the University, but marks are made available to tutors as soon as possible after the final meeting of the examiners. This is normally towards the end of week 7. Those intending to graduate with the BA (Geology) are given a classified result at this stage. Those continuing to Part B of the MEarthSc are only nominally classified, and may obtain their nominal classification from their tutor.

Please note that questions may also assume knowledge of relevant information from 1st and 2nd year courses.

Students must achieve a nominal classification of at least a 2.2 to proceed to 4th year.

HANDING IN THE MAPPING PROJECT

The completed field mapping project, including the electronic copy of the project and map, should be submitted to Emma Brown in Room 10.33, by 12 noon on Thursday of Week 0, Hilary Term.

PLEASE NOTE THAT THIS IS THE DEFINITIVE LIST OF ITEMS TO BE HANDED IN.

To facilitate distribution among the examiners, the report and all field materials must be contained in a SINGLE STANDARD BOX FILE.

DO NOT PUT YOUR CANDIDATE NUMBER ON ANY OF THE MATERIAL YOU HAND IN.

The submitted material should consist of

(a) one copy of the final report, (consisting of the final map and cross sections, an account of geological setting, lithologies, stratigraphy, structure, synthesis, references, etc.) should be self-contained, i.e. it should be intelligible without reference to the field materials

(b) one copy of the map

c) a digital copy of the final report (the write-up and the map)

(d) all field materials such as notebooks (electronic copy already handed in Michaelmas Term), field slips, cross sections and structural analysis performed in the field

(e) all thin sections

(f) a signed declaration form

g) the GeolSoc questionnaire and map
Students will receive £10 departmental printing credit for printing out their project. They may use the A0 printer on the ground floor to print the map. If there are any issues with either printer please flag this with the IT staff (helpdesk@earth.ox.ac.uk). Students may use the departmental binder and binding materials - please ask reception staff.

A “hand-in pack” will be available from Reception in Week 0 of Hilary Term. This will include:

- Box file
- Flash drive
- Packaging for thin sections

You can find the declaration of authorship and the GeolSoc mapping questionnaire on the Department weblearn site:

https://weblearn.ox.ac.uk/portal/site/%3Amps%3Aearth%3Augrad/page/be03fa79-51a8-4152-a8b3-fc4b5be567a6

Look under:

ES Undergraduate Courses/Examinations/Forms

The Examiners will normally award about 50% of the marks for the record of work done in the field, i.e. as recorded in notebooks and on field slips.

Students must adhere to a 6000-word limit for the project (excluding the declaration of authorship and word count, contents page, references, bibliography, figure captions, table captions, text in tables, text in diagrams, headers, footers, acknowledgements, disclaimers and appendices). Note that figure and table captions should only include directly relevant explanatory text. Inclusion of marginally relevant figures and tables should be avoided. Lithological and petrological descriptions should be integrated into the body of the report, not attached in appendices. In-text citations should be included in the word count. An accurate word count must be included, along with a signed statement that the project is your own work.

HANDING IN THE EXTENDED ESSAY

Students must adhere to a 4000-word limit for the essay (excluding the declaration of authorship and word count, contents page, references, bibliography, figure captions, table captions, text in tables, text in diagrams, headers, footers, acknowledgements, disclaimers and appendices). Note that figure and table captions should only include directly relevant explanatory text. Inclusion of marginally relevant figures and tables should be avoided. In-text citations should be included in the word count. An accurate word count must be included, along with a signed statement that the project is your own work.

You can find the declaration of authorship on the Department weblearn site:

https://weblearn.ox.ac.uk/portal/site/%3Amps%3Aearth%3Augrad/page/be03fa79-51a8-4152-a8b3-fc4b5be567a6

Look under:

ES Undergraduate Courses/Examinations/Forms

Two copies of the essay should be submitted to Emma Brown in Room 10.33, by 12 noon on Thursday of Week 0, Trinity Term.

Please note ONLY YOUR CANDIDATE NUMBER SHOULD BE ON THE ESSAY. Your name should NOT be on the essay.

Fourth Year Examinations (MEarthSc Part B)

Candidates must have achieved the equivalent of a minimum 2.2 classification in Part A in order to proceed into 4th year and Part B.
The fourth-year examination (Part B) consists of four theory papers, normally chosen from eight optional subjects, and an advanced practical project or extended essay, written up as a dissertation. The deadline for examination entry is set in the middle of Hilary Term, to allow candidates to make a considered selection of the options offered in Hilary Term.

Written Examinations
The written part of the Part B examination consists of eight two-hour papers, of which candidates have chosen four. They will probably take place in the Examination Schools during Week 7 of Trinity term (dates to be confirmed).

Candidates sit four out of eight of the following papers:

Paper 1 - Palaeobiology
Paper 2 - Planetary Chemistry
Paper 3 - Structure & Dynamics of the Earth’s Mantle
Paper 4 - Major Environmental Change
Paper 5 - Rock & Palaeo-magnetism
Paper 6 - Anatomy of a Mountain Belt
Paper 7 - Topics in Volcanology
Paper 8 - Topics in Oceanography

For all papers candidates answer two out of three questions.

Viva
All candidates have a compulsory viva of about 15 minutes with the External Examiner during his/her visit to the department, normally early in week 9. The examiner will speak to the student regarding their 4th year project and examination papers. This provides additional information for assessing the overall achievement of each candidate. Academic dress should be worn.

This interview is distinct from the project viva, which the student has with the two internal markers of their 4th year project. Further details of this may be found below in the section on the 4th year project.

Publication of Results
Results are published, and marks made available to tutors, as soon as possible after the final meeting of the examiners. This is normally towards the end of week 9.

Handing in the Fourth Year Project
The essay/project, should be double-spaced with a font size no smaller than 12 pt, should be accompanied by relevant references, tables and illustrations. This report should accurately and comprehensively describe the project, and normally would include the following:

1) An abstract
2) A concise description of the scientific background to the project
3) Aims and objectives
4) Experimental and data-collection procedures
5) Description of results
6) Interpretations of the results and analysis of their implications
7) A statement of conclusions
8) Identification of any information or data used as part of the project but originating from other individuals or organizations
9) A reference list

Appendices should be used principally for presenting supplementary information that does not form a central aspect of the project.

Students must adhere to an 8000-word limit for the project (excluding the declaration of authorship and word count, contents page, references, bibliography, figure captions, table captions, text in tables, text in diagrams, headers, footers, acknowledgements, disclaimers and appendices). Note that figure and table captions should only include directly relevant explanatory text. Inclusion of marginally relevant figures and tables should be avoided. In-text citations should be included in the word count. An accurate word count must be included, along with a signed statement that the project is your own work.

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You can find the declaration of authorship on the Department weblearn site:

https://weblearn.ox.ac.uk/portal/site/%3Amps%3Aearth%3Augrad/page/be03fa79-51a8-4152-a8b3-fc4b5be567a6

Look under:

ES Undergraduate Courses/Examinations/Forms

Please note ONLY YOUR NAME SHOULD BE ON THE PROJECT. Your candidate number should NOT be on the project.

Students should submit an 8-page report on their project to their supervisor by 12.00pm on Friday of Week 1 in Hilary Term. The progress report will not be marked or count in any way towards your final degree result. It is designed merely to be helpful in crystallizing your thoughts and to give you feedback on your progress and your writing skills.

A complete draft of the project must be handed to the lead supervisor for formal feedback by the end of Week 0 of Trinity Term at the latest. The supervisor will return this draft along with any comments to the student by the end of Week 1. Comments will be restricted to one A4 page, 12 point font. This page is also provided to the project assessors and Examiners. If the supervisor is likely to be away/on leave during Week 1, the student and supervisor should make alternative arrangements well in advance. The lead supervisor will also submit to the examiners a one page report on the amount and nature of supervision given to the student, by the end of 1st week.

Supervisors or co-supervisors should not comment on written drafts (other than the material handed in after Christmas) until the formal draft is handed in at the end of week 0, and then the lead supervisor (or a designated supervisor) provides one page of feedback by the end of week 1. Discussion on data, diagrams, or plots of data etc, forms part of the normal supervision process.

The fourth-year project is double marked by two internal assessors, neither of whom were involved in supervising the project, and moderated by the Examiners.

The two internal markers will be allocated after submission of the project. A viva, conducted by the two markers, will be a formal part of the process of marking the dissertation. This viva will take place between Weeks 2 and 6 of Trinity Term, that is after the final project report has been submitted, and before commencement of the written examinations. The viva will usually last between 30 minutes and 1 hour, and will be a discussion of the project material by the candidate and the two markers. It will be an opportunity for the markers to explore the depth of a student’s knowledge of their project, and also to discuss the conduct, science, and background of the work. Sub fusc is not required for the project viva.

Please note that the project viva is distinct from the interview with the external examiner.

4th year students’ informal presentation to their peers (the “Mini Conference”) may take place early in Trinity Term but forms no part in the assigning of marks to the 4th year project.

Three copies, plus a pdf, of the final version of the project must be submitted to Emma Brown in room 10.33 by 14.00 on Thursday of 2nd Week of Trinity Term of the 4th year. Students should retain a fourth copy of the project for their own use.

If you have any problem producing the pdf, please contact the Academic Administration Office.

After marking, two copies will be deposited in the library of the Department of Earth Sciences, and the third copy given to the supervisor. Current practice is for the department to reimburse the cost of binding (SOFT binding only) one library copy on presentation of a receipt to the Accounts Office.
### Class Descriptors

<table>
<thead>
<tr>
<th>Marks</th>
<th>Descriptor for WRITTEN ANSWERS</th>
<th>Descriptor for PROBLEMS</th>
</tr>
</thead>
</table>
| 90-100 | 1. Outstanding answer; full of insight; exceptional command of material.  
2. Well organized with introduction, critical discussion, illustrations, and conclusions.  
3. Reference to key connections across the course and the literature.  
4. No errors. | 1. Formulation of the problem and choice (or derivation) of relevant equations show complete understanding, including background, limitations of approach, comparison with alternatives.  
2. All assumptions and logical steps are clearly explained and fully justified.  
3. Algebraic manipulation and/or calculations are without errors. |
| 80-90 | 1. Excellent answer; evidence for both wide knowledge, and understanding of subject. Effective critical analysis.  
2. Structure reflects full clarity of thought, fully illustrated as necessary.  
3. Goes well beyond lectures; effective grasp of literature/debate. Insightful connections and comparisons across the course.  
4. No errors. | 1. Formulation of problem, choice (or derivation) of relevant equations show excellent understanding, including some background, limitations of approach, comparison with alternatives.  
2. All assumptions and logical steps are clearly explained and justified.  
3. Algebraic manipulation and/or calculations have no errors. |
| 70-80 | 1. Very good understanding of all essential presented course material, inclusion of relevant details. Integration of outside reading; some critical analysis.  
2. Good structure, well written and well-illustrated.  
3. Clear ability to make relevant connections across the course (including background, field observations).  
4. No errors. | 1. Formulation of problem, choice (or derivation) of relevant equations show very good understanding, and justifications are clearly explained.  
2. The principal assumptions and logical steps are clearly explained and justified.  
3. Algebraic manipulation and/or calculations are without substantial error. |
| 60-70 | 1. Sound understanding of all essential presented course material.  
2. Coherent, clearly annotated and labeled illustrations as necessary. Reasonable organization reflecting clear understanding.  
3. Includes essential connections across the course.  
4. No errors. | 1. Formulation of the problem and choice (or derivation) of relevant equations show good understanding and are justified.  
2. The principal assumptions and logical steps are explained.  
3. There may be small errors in algebraic manipulation and/or calculations. |
| 50-60 | 1. Some key information from lectures or coursework missing. Demonstrates understanding of only part of answer.  
2. Some structure.  
3. No connections across coursework. Little signs of originality.  
4. Large and small factual errors. | 1. Formulation of the problem and choice (or derivation) of relevant equations are not justified and do not show full understanding.  
2. Some assumptions are not stated, and there are gaps in the logic of the calculation.  
3. Errors in algebraic manipulation or calculation lead to incorrect or incomplete answers. |
| 40-50 | 1. Most of relevant information in lectures missing. Concepts disordered or flawed. Demonstrates inadequate understanding.  
2. Incompletely structured answers.  
3. No connections across coursework.  
4. Many significant factual errors. | 1. Formulation of problem and choice (or derivation) of relevant equations show inadequate understanding.  
2. Assumptions are not stated, and there is little or no logic to the calculation.  
3. Errors in algebraic manipulation or calculation lead to unrealistic answers, or to no answer. |
| 0-40 | 1. Significant inability to tackle question.  
2. Incoherent structure, disconnected information.  
3. Inclusion of information irrelevant to the question.  
4. Minimal correct information. | 1. Significant inability to tackle the question.  
2. Problem approach not formulated. Incorrect or irrelevant formulae used.  
3. Little or no relevant calculation. |
Weighting

Weighting of Papers and Marks in Part A and Part B for students who started the course from 2013 onwards

<table>
<thead>
<tr>
<th>Year</th>
<th>Exam</th>
<th>Weighting</th>
<th>Percentage of Final degree classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part A1 (2nd year)</td>
<td>Paper 1</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper 2</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper 3</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>120</td>
<td>12%</td>
</tr>
<tr>
<td>Part A2 (3rd year)</td>
<td>Paper 1 (Fieldwork)</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper 2</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper 3</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper 4</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper 5</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper 6</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper 7</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>280</td>
<td>28%</td>
</tr>
<tr>
<td></td>
<td>Independent Essay</td>
<td>50</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Mapping Project</td>
<td>100</td>
<td>10%</td>
</tr>
<tr>
<td>Subtotal (A2)</td>
<td></td>
<td>430</td>
<td>43%</td>
</tr>
<tr>
<td>TOTAL:</td>
<td></td>
<td>550</td>
<td>55%</td>
</tr>
</tbody>
</table>

The marks from the second-year examination are brought forward from the previous year. Those taking the three-year B.A. (Hons) will have their degree awarded on the basis of the above marks.

The weightings for Part B are as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Exam</th>
<th>Weighting</th>
<th>Percentage of Final degree classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th</td>
<td>Theory 1</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Theory 2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Theory 3</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Theory 4</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>200</td>
<td>20%</td>
</tr>
<tr>
<td>4th Year Project</td>
<td></td>
<td>250</td>
<td>25%</td>
</tr>
<tr>
<td>TOTAL:</td>
<td></td>
<td>450</td>
<td>45%</td>
</tr>
</tbody>
</table>

The final MEarthSc degree is based on a final mark derived by summing the final percentages of Part A and Part B. Classification of the degree is guided by the class divisions summarised below, but also takes into account the interview conducted with the External Examiner, and the practical work deposited by the candidates.
Appendix 2 - PROGRAMME SPECIFICATIONS

EARTH SCIENCES  BA/Geol and MESc/ES
Programme Specification

1. Awarding institution/body University of Oxford
2. Teaching institution University of Oxford
3. Final award MEarthSc (4-year) or BA (Geology) (3-year)
4. Programme Earth Sciences
5. UCAS code F644 (MESc/ES) or F642 (BA/Geol)
6. Relevant subject benchmark statement Earth Sciences, Environmental Sciences and Environmental Studies
7. Accreditation Geological Society of London
8. Date of programme specification October 2019

9. Educational aims of the programme

These are built around the QAA framework for higher education qualification and the QAA Subject Benchmark statements.

- To provide a course of the highest academic quality in Earth Sciences in a challenging and supportive learning environment that attracts the very best students from the UK and elsewhere.
- To provide Bachelor’s degree students with a systematic understanding of core areas and advanced topics in the Earth Sciences; the ability to evaluate primary evidence critically; and the conceptual understanding to marshal and present arguments and solutions based on primary data, theory, and the application of sound reasoning.
- To provide Master’s degree students also with a critical awareness of current problems and new insights, much of which is at, or informed by, the forefront of Earth Sciences research, together with a comprehensive understanding of techniques applicable to their own research project, originality and conceptual understanding.
- To develop transferable skills related to problem solving, communication, practical fieldwork, and computing.
- To bring students to a position on graduation that allows them to choose confidently from many different careers, whether within Earth Sciences or not, and enables them to contribute rapidly to their chosen employment.
- In addition those completing the 4-year MEarthSc will:
  - Build on the core knowledge and training of the BA course and develop a more advanced understanding.
  - Undertake a research project that will further develop research skills;
  - Be in a position to start graduate study for a research degree at a leading university either in the UK or overseas or pursue a scientifically based career.

10. Programme outcomes

These are built around the QAA Subject benchmark statements.
A. Students will develop a knowledge and understanding of:

- Fundamental principles of physics, chemistry and biology of relevance to the Earth Sciences
- The general holistic, multidisciplinary and interdisciplinary nature of the Earth Sciences
- The integration of field based, experimental and theoretical principles needed for the Earth Sciences
- Mathematical, quantitative and qualitative approaches and their application to problem solving
- Basic computer programming and numerical methods as applied in the earth sciences

Related teaching/learning methods and strategies

- **Lectures** are the principal means by which the course content is delivered to the students. Lecturers will generally use lectures to outline the areas of knowledge they wish the student to be familiar with, and to emphasise particularly important concepts.

- **Practicals** supplement and extend the lecture course, and allow the students to determine whether they really understand the content of the lectures. They also give an opportunity to develop key skills.

- **Tutorials** provide a flexible forum for small-group teaching. A principal function of tutorials is to develop intellectual skills and allow exploration of a subject beyond the confines set in lectures. This can be tailored to the specific interests of the students and the tutor.

- **Fieldwork** is an integral part of the course structure. The field courses are designed to build upon theoretical and practical knowledge gained in all aspects of the course.

- **Mapping Projects** allow students to undertake geological mapping of an area, and develop initiative and self-reliance regarding field observations.

- **Independent Research** introduces students to scientific research first hand, working with a Faculty member.

- **Computing** involves the manipulation of numerical datasets and interactive comparisons of observation with models.

- **Private study** particularly during the vacations is both necessary and expected, as it provides opportunities for consolidation and for reading beyond and around the syllabus.

Assessment

Public (university) examinations are taken in the summer term of each year of the course.

The **Preliminary Examination** is a pass/fail examination covering the foundation topics of the first year in Earth Sciences. The examination comprises four theory papers and a timed practical. It must be passed (a resit is allowed in September) to proceed further on either of the 3- or 4-year courses. The marks do not count towards the degree classification.

There are two Final Honours Schools - the 3 year BA (Hons) and the 4-year MEarthSc (Hons). Both schools share the same examinations in years 2 and 3.

The **Final Examination** for the 3-year Honour School in Geology is taken at the end of years 2 and 3. At the end of Year 2 students are required to satisfy the examiners in three papers, including practical components. At the end of Year 3 students must satisfy the examiner in a further seven papers, plus two pieces of independent work. They are required to attend such field courses during each year of study as are approved annually by the Faculty of Earth Sciences, and make available to the examiners practical notebooks containing records of both field and laboratory courses. Marks from the Second Year examination are carried forward to Third Year.

The **Final Examination** for the 4-year Honour School in Earth Sciences is taken in two parts. Part A of the examination is taken at the end of Years 2 and 3 and is the same as that for the three-year course in Geology above. Part B of the examination is be taken at a time not less than three terms after Part A, and consists of written papers on four subjects chosen from a list published by the Faculty of Earth Sciences, a report on an advanced practical project or other advanced work.
Formative assessments are carried out within the college context through tutorials, classes and termly examinations (collections) and within the context of the teaching laboratories through practicals.

B. Skills and other attributes

These are built around the QAA Subject benchmark statements.

Students will have the opportunity to develop the following skills during the course:

2. Intellectual skills

- Appreciation of the holistic, multidisciplinary and interdisciplinary nature of the Earth Sciences
- Appreciation of the unity of underlying physical, chemical and biological principles of the Earth Sciences and their interactions in Earth systems processes
- Ability to recognise and use subject-specific theories, paradigms, concepts and principles (such as plate tectonic theory, evolutionary theory, the principle of uniformity)
- Ability to apply knowledge and understanding to address familiar or unresolved and more open-ended problems using fundamental principles
- Ability to collect, analyse, synthesise, summarise and inter-relate a wide range of phenomena and facts, including unresolved observational and complex information, to formulate and test hypotheses and reach conclusions, using both quantitative and qualitative approaches
- Ability to apply appropriate mathematical or numerical techniques to model geological and geophysical phenomena
- Ability to conduct a logical discussion
- Ability to précis scientific arguments and facts and give succinct and written presentations, using IT based methods where appropriate
- Awareness of the importance of creativity and the scientific imagination in formulating hypotheses from careful observations and analyses

3. Practical skills

These are built around the QAA Subject benchmark statements.

- Appreciation of the paramount importance of high quality field observation and practical skills to Earth systems analysis
- Ability to make and record accurate observations of field phenomena at a range of scales from maps to hand specimens, and to be able to analyse and make scientifically rigorous or testable conclusions from these observations
- Ability to make appropriate use of the terminology, nomenclature and classification systems used in the Earth Sciences (such as crystallography, mineralogy, petrography, biological taxonomy and the Linnean system).
- Ability to carry out accurate measurements using a range of techniques and data acquisition systems
- Ability to integrate field work, experimental and theoretical data
- Awareness of the need for safety in the field and practical laboratories, and ability to ensure safe conduct through risk assessment, awareness of rights of access, relevant health and safety regulations and sensitivity of the investigations on the environment and stakeholders
- Ability to plan, conduct and report on an open ended project, including the use of secondary data
- Ability to reference work in an appropriate manner

**III. Transferable skills**

These are built around the QAA Subject benchmark statements.

**A. Communication skills**

- Receiving and responding to a variety of information sources (e.g. textual, numerical, verbal, graphical) [LTC] [Tt] (U) (C)
- Communicating effectively and appropriately to a variety of audiences in written, verbal and graphical forms [LTC] [Tt] [M] (U) (C)

**B. Problem solving, numeracy and IT skills**

- Problem solving in a variety of contexts, and the ability to relate problems to first principles  [LTC] [Tt] (U) (C)
- Appreciation of the issue of sample selection, accuracy, precision and uncertainty, including the collection, recording and analysis of data in the field and the laboratory  [LTC] [Tt] [M] (P)
- Ability to prepare, process, interpret and present data using appropriate qualitative and quantitative techniques and packages  [LTC] [Tt] [M] (U) (C) (P)
- Ability to solve numerical problems using computer and non-computer based techniques  [LTC] [Tt] (U) (C) (P)
- Ability to devise and manipulate mathematical and numerical models  [LTC] [Tt] (U) (C) (P)
- Familiarity with IT for documentation production and information retrieval  [LTC] [Tt] [M] (U) (C) (P)
- Ability to use the Internet critically as a means of communication and a source of information  [LTC] [Tt] (C) (P)

**C. Interpersonal/Teamwork skills**

- Development of organisational skills for practical tasks  [LTC] [Tt] [M] (C) (P)
- Ability to identify individual and collective goals and responsibilities and perform in a manner appropriate for these roles  [LTC] [Tt] [M] (C) (P)
- Ability to recognise and respect the views and opinions of other team members  [LTC] [Tt] (C) [M] (P)
- Ability to evaluate performance as an individual and as a team member  [LTC] [Tt] (C) [M] (P)

**D Self management and professional development skills**

- Development of the skills necessary for self-managed and lifelong learning (e.g. working independently, time management and organisational skills)  [LTC] [Tt] ([M] C) (P)
- Ability to identify and work towards targets for personal, academic and career development [Tt] [M] (C) (P)
- Development of an adaptable and flexible approach to study and work [Tt] [M] (C) (P)
- Foreign language ability (optional for those who wish to maintain or improve a language) [F]

**Teaching/Learning methods and strategies**
These are built around the QAA Subject benchmark statements

The teaching and learning skills are acquired through the following methods and strategies. Each symbol is shown in brackets in the list above.

**LTC**: Lectures, tutorials and classes. Most teaching is in the form of lectures and associated practicals. These may be supported by tutorials and classes according to the needs and interests of the student and the tutor.

**Tt**: Tutorials and writing up in practicals. Tutorials at Oxford hold a very special place in the expansion of personal Graduate Key Skills (such as intellectual development, self-management, powers of communication).

**M**: writing up of field work, independent mapping project, 3rd year essay, 4th year project. Field-based studies allow students to develop and enhance many of the Graduate Key Skills (such as teamworking, problem-solving, self-management, interpersonal relationships), which are of value to employers and for life-long learning, as do the essay and projects.

**F**: Foreign language tuition is an option that can be taken in the second and third year and is taught by the University Language Teaching Centre. These skills are not assessed by us.

**Assessment**

These are built around the QAA Subject benchmark statements.

The teaching and learning skills are assessed by a combination of the following. Each symbol is shown in brackets in the list above.

**U**: Unseen written examinations and specific practicals in the computer teaching laboratory. Examinations are rigorously overseen by the Examination Schools, where some of the written examinations may be taken.

College examinations (organised centrally as departmental collections) are arranged after the Summer vacation and Christmas vacation for those students not sitting a formal examination that term or year. These marks are for assessment of progress and do not count towards the degree.

**C**: Tutorial collections at the end of each term and written feedback on field notebooks. Each student will receive or hear written feedback on their tutorial work during the term at end of term collections. At Oxford, the reports are for the assessment of progress and do not count towards the final degree class.

**P**: Fourth year project and assessed short talks in the department and on field courses. The projects are marked formally. The talks are assessed informally.

11. **Programme Structures and Features**

These are built around the QAA Subject benchmark statements.

- A four year course leading to the degree of Master of Earth Sciences with honours or a three year course leading to the BA (Hons). The first three years are common to both courses.

- The first year covers multidisciplinary, foundation material in Planet Earth, Crystallography, Mineralogy and Petrology, Sedimentology, Palaeontology, Maps and Practical Skills, Chemistry, Physics and Biology and Mathematics. The five Programme Outcomes are introduced here (A1 through lectures, tutorials, practicals and classes, A2-A5 also through field courses). The Preliminary Examination in Earth Sciences (First Public Examination) is taken at the end of the year (with a resit in September) and must be passed to continue on the course.

- The course leading to MEarthSc occupies the remaining three years leading to examinations at the end of each year. The multidisciplinary and interdisciplinary Programme Outcomes are developed here (A1 through lectures, tutorials, practicals and classes, A2-A5 also through field courses).
The BA (Hons) course takes two years with exams at the end of the year. The multidisciplinary and interdisciplinary Programme Outcomes are developed here (A1 through lectures, tutorials, practicals and classes, A2-A5 also through field courses).

The programme is enhanced throughout by tutorial teaching, arranged in association with the colleges. Tutorials reinforce understanding of the fundamental principles in physics, chemistry, biology, mathematics, and in Earth Systems Science. They contribute markedly to the development of personal Graduate Key Skills (such as intellectual development, self-management, powers of communication).

### Learning: Year 1

**Subjects**
- Planet Earth
- Crystallography, Mineralogy, Petrology, and Sedimentology
- Maps & Practical Skills and Palaeontology
- Chemistry, Physics & Biology
- Mathematics

**Practicals**
- Problem Classes
- Field Programme

**Assessment (Preliminary Examination in Earth Sciences)**
The four written papers, each of 3 hours, must be passed (pass mark 40%) in one examination. Students failing up to two papers may retake these in September. Failure on more than two papers requires all four to be taken again. Practical work is assessed in examinations, which count as 50% of the marks of two of the written papers. The examiners may award a distinction to those who show special merit across all the tests and have passed all papers at one sitting. The first field course takes place in Michaelmas Term and the second at Easter, plus day excursions in Trinity Term.

### Year 2

**Subjects**
- Sedimentary Geology
- Structural Geology
- Igneous and Metamorphic Petrology
- Maps
- Geophysical Methods in Geology
- Mathematical Tools
- Isotope Geology
- Thermodynamics
- The Carbon Cycle
- Evolution
- Remote Sensing and Active Tectonics
- Earthquakes & Faulting

**Problem Classes**
- Practical Work
- Field Programme
- Independent Mapping Project

**Assessment (both MEarthSc and BA)**
Three papers, combining theory and practical elements, are taken at the end of the summer term. Two field courses take place, one in Michaelmas Term and one at Easter. A report on an individual mapping project is undertaken during the summer break and the report submitted at the beginning of Hilary Term of year 3.

### Year 3

**Subjects (students chose six courses from the following options)**
- Sedimentary Basins
Natural Resources
Biological & Physical Oceanography
Volcanology, Igneous Processes & Petrogenesis
Climate
Vertebrate Palaeobiology
Seismology & Earth Structure/Vector Calculus
Geodynamics
Earth Materials, Rock Deformation & Metamorphism

Essay
Practical Work
Field Programme

Assessment (both MEarthSc and BA)
Students have an element of choice as to which major subjects to take this year. An extended essay is to be undertaken in Hilary Term of the third year. Six (chosen out of nine) two-hour theory papers plus one compulsory fieldwork and interdisciplinary paper are taken at the end of the summer term. The Spanish field course takes place at Easter each year.

Year 4
Subjects (students choose four courses from the following options)
Anatomy of a Mountain Belt
Planetary Chemistry
Structure and Dynamics of the Earth's Mantle
Palaeobiology
Records of Major Environmental Change in Earth History
Environmental, Rock, and Palaeo-magnetism
Topics in Oceanography
Topics in Volcanology

Project

Assessment (MEarthSc)
Four two hour written papers are taken at the end of Trinity (summer) term. The project is undertaken during Michaelmas, Hilary, and Trinity terms of the 4th year and written up for submission to the examiners on Friday of week 4 of Trinity Term.

There are two field courses at the beginning of the 4th year. Students may go to Bermuda or Greece.

12. Support for Students and their learning

- All undergraduates reading Earth Sciences have a college tutor responsible for their academic welfare. This person will normally also hold a university teaching post in the Earth Sciences department. In addition to college tutors, College Deans provide more general welfare support and liaise with the University Counselling Service. Most Colleges are able to house most of their undergraduates throughout the course and provide social and sports facilities.

- During the first three years of the Earth Sciences courses, college tutors are responsible for organising the tutorial and class teaching that complements and exercises the material covered in lectures.

- The department has teaching laboratories and collections for Palaeobiology, Mineralogy and Petrology, and computing; these are available to students at all times. Students on projects will also have access to the research laboratories, under strict supervision.

- All colleges have good library provision and at university level, the Hooke library provides a lending service for science subjects. Undergraduates are also entitled to make use of the Radcliffe Science Library (non-lending research library). The department also has its own library, with open access, and it is a valuable resource for the students.

- The department has a Computing Officer and use of IT and the web is continually expanding. Students have access to computers in college and in the teaching laboratories. Many college rooms have internet access. The network of IT resources and support is extensive, especially the Oxford University IT
Services, which provides facilities for undergraduates and graduates, plus an extensive range of training programmes.

- Information about the courses is provided in the Undergraduate Course Handbook (distributed at the start of each year to all Earth Science undergraduates in residence) and more information and links to Earth Science sites worldwide are provided by the Earth Science department website (www.earth.ox.ac.uk).

- Advice on course content/options for undergraduates is provided by college tutors.

- Extensive facilities for language development for personal purposes are available through the University Language Centre.

- Regular personal contact between students and tutors ensures that problems are addressed promptly. The University Counselling Service offers a range of assistance.

13. Criteria for Admission

- A-Level Mathematics plus either Physics or Chemistry at A-level are required. All three are useful, but candidates lacking one of these core subjects but with an A-level or additional AS-level in Geology, Biology, Further Mathematics, or Geography are also encouraged to apply, as of course are candidates with other qualifications such as the International Baccalaureate, Scottish Highers, etc.

- Applications are made to colleges of the University (undergraduates) or the department (graduates). Two meetings of all those involved in college interviewing are held in the department to arrange second round interviews and to ensure that the best qualified candidates overall are offered places.

- Tutors are looking for enthusiastic and highly motivated students with the ability to apply basic principles to unfamiliar situations. Offers are made on the basis of a student's academic record, the recommendations of their teachers, and their performance in interviews in December.

- The purpose of the interviews is to determine those students, from an excellent calibre of applicants, who might be seen to benefit from the intensive, multidisciplinary, interdisciplinary and tutorial-based learning of the course.

- The courses require a good level of mathematical competence, but the key requirement is the ability to formulate a problem quantitatively and to be able to extract the consequences from the solution.

- Applicants are expected to meet the University's English Language criteria.

14. Methods for evaluating and improving the quality and standards of learning

- The Mathematical, Physical and Life Sciences divisional committees ensure the dissemination of best practice between departments.

- The quality of the course is monitored on a regular basis by the Earth Science Faculty (essentially all staff involved in teaching in any capacity) and the Academic Committee. Input to these bodies comes from:
  - Internal Examiner's reports
  - External Examiner's reports
  - Earth Science Joint Consultative Committee (staff-student)
  - Termly student feedback on quality of lectures.

- Student comment on tutorial provision is requested by their colleges and is reviewed by Senior Tutors.

- The External Examiner's Reports and the response of the department to any issues raised are also considered by the Academic Audit Sub-Committee of the Division of Mathematical, Physical and Life Sciences.

- University reviews of the department are carried out jointly by the division and Education Committee every six years.
• Issues relating to the improvement of teaching can be raised by the processes of mentoring of new lecturers during the five year probation, by feedback during their Oxford Learning Institute (OLI) training, through the divisional academic advisor, and by the appraisal process. Mentoring and arranging training in OLI are the responsibility of the department; the appraisal process is the responsibility of the Divisional Board.

• Accreditation report by the Geological Society of London.

15. Regulation of assessment

Final Examination

• The final examinations are each conducted by a team of 3 internal examiners plus one external examiner. Examiners are currently nominated by the departmental Academic Committee. Acceptance of these examiners is the responsibility of Faculty. The normal term of duty is two years. Examiners are guided by conventions agreed by the Faculty, endorsed by the division, and made available to students in the Course Handbook. Oversight of all public university examinations is carried out by the Junior Proctor and staff. Any complaint or application for mitigation must be made through the Proctor.

• Candidate anonymity is provided by random candidate numbers, known only by Examinations Schools until the final examinations meeting. Dispensation from anonymity has been agreed for the Independent Mapping Project and 4th year Research Project, for practical reasons.

• All Part A and Part B Finals examination material is double marked. Assessors and examiners carefully consider any cases where there is a notable difference between the marks awarded by the two assessors.

• There is an opportunity for candidates who fail any Prelims examinations to resit those papers over the long summer vacation. Part A candidates who fail may be permitted to resit the examination in the following academic year.

The department has adopted the divisional template for class descriptors, as outlined below, but also provides its own more detailed guidance to assessors.

<table>
<thead>
<tr>
<th>Divisional Template for Qualitative Descriptors of Classes</th>
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<tr>
<td>Class I</td>
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<td>Class IIi</td>
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<td>Class IIii</td>
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<td>Class III</td>
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<tr>
<td>Pass</td>
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<tr>
<td>Fail</td>
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16. Indicators of quality and standards

• External Examiners Reports

• Reports of external review bodies (see Sec.13)

• Student feedback
• Review jointly by the division and Education Committee

• The department topped the ranking for research quality in the 2014 Research Excellent Framework with a score of 3.4.
Appendix 3 - STANDING ORDERS

1. Name of Board: 
*MEarthSc and BA Geology:*

Preliminary Examinations ("Prelims")

Finals examinations ("Finals"), which includes Part A (Part A1 - 2nd year, Part A2 - 3rd year) and Part B (4th year)

2. Principal contact for nominations/appointments:

Professor Conall MacNiocaill / Ms Emma Brown

3. Number of internal examiners:

Three internal examiners are required from the Faculty of Earth Sciences for Finals examinations.
Three internal examiners are required from the Faculty of Earth Sciences for Prelims examinations.

4. Term of office for internal examiners: The term of office for internal examiners shall be three years, with a maximum of two consecutive terms on the same board of examiners.

5. Term of office for the chair of examiners: The term of office for the chair of examiners shall be one year, which may be renewed once.

6. Number of external examiners and term of office:

One external examiner is required for Part A and one external examiner is required for Part B. The period of office of each external examiner is usually two years with the Part A examiner becoming the Part B examiner in the succeeding year.

No external examiner is required for the Prelims examination.

7. B.A. and M. Earth Sciences

All matters relating to teaching and content of the courses are reviewed by the Teaching Committee which reports to the Faculty.

The Teaching Committee shall ensure that the Course Handbook and the Examination Conventions are reviewed and published annually and will report to the Faculty of Earth Sciences for approval.

8. Nomination of Examiners

The Teaching Committee will consult and recommend to the Faculty on the appointment of internal and examiners.

9. Examiners’ Report

The Teaching Committee shall receive and consider the internal and external examiners' reports on the examinations at the Michaelmas Term meeting. The examiners' reports and a draft response to the comments made by the external examiners will be forwarded in consultation with the internal examiners to the Faculty for approval.

The Teaching Committee also considers the following matters and recommends to the Faculty for discussion and approval:

(i) Quality assurance matters (review of course questionnaires and feedback (monitored by the Chairman) from students
(ii) Reports of the Joint Consultative Committees for Undergraduate (JCCU) and Graduate (JCCG) Studies.

The Teaching Committee will also consider examination conventions and examination regulations and pass these annually to Faculty for approval.

10. Reporting to the MPLS Division

Reports to the MPLS Division are sought at various times of the year, as set out in the EdC/MPLS Quality Assurance and Quality Enhancement Calendar. For example, reports on examination reports are provided at the start of Hilary Term, and are considered by the MPLS Academic Audit Sub-Committee. The Chairman of the Faculty of Earth Sciences attends meetings of the MPLS Education committee and academic audit sub-committee to ensure good communication, feedback, and sharing good practice.
Appendix 4 - TRAVEL INSURANCE

Travel insurance cover is available to University employees, students and volunteers travelling on University Business.

The travel insurance application form must be completed at the time of booking the trip and presented to the appropriate Departmental Administrator to enable travel insurance cover to be arranged.

Please refer to the University website www.admin.ox.ac.uk/finance/insurance/travel in order to check your eligibility for cover, countries requiring specific referral, cover details, and how to apply.

Please note:

1. You may be required to prepare a full risk assessment for your travel: see Policy Statement S3/07 at www.admin.ox.ac.uk/safety/policy-statements for details, in order for cover to apply

2. All travel insurance claims are settled net of a standard excess of £50.

3. Please list on this form all personal items over £500 in value for which you require cover. We strongly advise you not to take valuable items with you while travelling.

4. All theft claims must be supported by a local police/security report.

5. All property damage claims must be supported by an estimate for repair, detailing the extent of the damage and the cost of repair. If the item is beyond economical repair a quotation for replacement must be supplied with the claim. You may also be asked to supply a receipt for the original item.

6. Pre-existing medical conditions
   The University’s travel policy includes cover for emergency medical expenses resulting from a pre-existing medical condition, however, cover will not operate in respect of journeys taken against the advice of a Qualified Medical Practitioner or where any existing medical condition is not under control and it is foreseeable that medical assistance may be needed on a journey
   It is strongly recommended that if you suffer from a pre-existing medical condition you visit your GP prior to travelling in order to check that you are fit to travel and undertake the duties intended. This will ensure that in the event of a claim, evidence is available to confirm you were not travelling against medical advice and that any existing medical conditions were considered under control at the start of your Journey.

7. Personal Medical Information: Travellers are advised that, in the event of a claim for medical expenses, you will be required to provide personal medical information (by way of the claim form) to the University Insurance Team. This is required by the Insurer in order to settle the claim. In the event that the traveller wishes to keep this information confidential from the University Insurance Team, arrangements can be made for the information to be sent direct to the Insurer.

8. Emergency contact details are available at www.admin.ox.ac.uk/finance/insurance/travel and should be taken with you when you travel. The Emergency Assistance Provider MUST be contacted in the event that emergency repatriation is required.
A list of key contact contacts for undergraduate students can be found below.

For a full list of staff and researchers, please see the website:

www.earth.ox.ac.uk/people

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<th>Name</th>
<th>Post</th>
<th>Rm</th>
<th>Tel</th>
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<tr>
<td>Chris Ballentine</td>
<td>Head of Department</td>
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<td>72938</td>
<td><a href="mailto:chris.ballentine@earth.ox.ac.uk">chris.ballentine@earth.ox.ac.uk</a></td>
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<td>72007</td>
<td><a href="mailto:ian.wright@earth.ox.ac.uk">ian.wright@earth.ox.ac.uk</a></td>
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Appendix 6 - LIBRARY INFORMATION

This guide gives an overview of the Departmental Library and introduces some of the other libraries that cover Earth Science subjects. The librarian is here to help you find the resources you need, so please do not hesitate to ask. There are also web pages, which can be found here:

https://www.earth.ox.ac.uk/about/library/

Opening Hours

Members of the Department have 24-hour swipe access to the Library. The librarian’s working hours are variable but the library is usually staffed between 9am and 1pm each day, and until 3pm on Tuesdays and Thursdays.

Books

Books can be found by searching SOLO, which can be found at:

http://solo.bodleian.ox.ac.uk/primo-explore/search?vid=SOLO

This resource discovery tool gives details of the books held throughout the libraries of the university (some colleges are not included e.g. University College).

It will indicate:
- the library (for example, books in this library will have the location EAR Main Libr or EAR Basement).
- the shelfmark, which indicates where the book can be found within each library
- the loan status, e.g. ‘Confined’ (when a book is for library use only) or ‘Available’ (when a book can be borrowed).

Borrowing

To borrow from the library, use the self-check machine.

- Choose ‘Borrow & Renew’
- Scan the barcode on your university card
- Place books on the laminated sign
- A list of books will appear in green once they have been issued
- Select ‘finish’

*Incorrectly issued books will set off the alarm.*

If you set of the alarm:

- Try issuing the book again
- Check if it is a reference book or a confined book - these books must not be taken out of the library.
- If it continues to set off the alarm, leave it on the desk for investigation when the librarian is next available

Returns

You can return books using the self-check machine

- Select ‘return’
- Place books on the pad
- A list of books will appear when they have been returned correctly
- Press ‘finish’
- Place books on the trolley
*If a hold is activated, put the book in the Returns Box on the librarian’s desk.*

If you encounter any problems, enter your university card barcode and the barcode of the book in the notebook provided.

**Hold Requests**
To ensure a book is held for you when it is returned by another reader:
• Sign on to SOLO
• Click ‘Hold’
The librarian will email you when it becomes available.
You will need to scan it out as usual when you collect it.

**Renewals**
Renew your books as soon as you receive a ‘Library Reminder’ email.
Sign in to your account on SOLO for:
• A list of books you have on loan
• The date they are due back
• Renewal functions
Books can be renewed 9 times. After that they need to be returned to the library and re-issued (if the book isn’t needed by another reader).

**Fines**
Fines are not currently charged - if loans are not returned promptly this will be revised.

**Lost Books**
You remain responsible for a book until it is returned.
Do not give books to another reader unless they have been returned and re-issued.
In cases of loss or damage you will be asked to buy a replacement.

One week before the end of each term all outstanding loans must be returned to the Library. Books may then be borrowed for the vacation.

**Confined Cupboard**
Books kept in the Confined Cupboard must not be taken out of the library.
There is a card at the front of each book:
• Fill in your name and the date borrowed
• Leave the card in the gap on the shelf
Return the book to the librarian’s desk at the end of each day.

**Material in the Basement**
Access to the basement material is available on request.
It houses:
• British Geological Survey Memoirs, Regional Guides, Bulletins
• Departmental DPhil Theses
• Ocean Drilling Programme Reports
• Decade of North American Geology
• Departmental Reprints
• Palaeontographical Society Monographs
• Journals
• Worldwide Geology
Journals

A range of journals are held in hard copy by the library. Current subscriptions are in the main library, and those that are not currently under subscription are kept in the basement and can be fetched on request.

Access to e-journals is via OxLIP+

Borrowing journals:
NO periodicals may be borrowed. (See Photocopying)

Maps

The library holds a good collection of topographical and geological maps as follows:
- Ordnance Survey and foreign topographical maps are kept in the Confined Cupboard
- BGS folded maps are kept in the Confined Cupboard
- Flat BGS maps are in map cabinets in the library (please ask the librarian for keys)
- Foreign geological maps are kept in a variety of map cabinets and drawers (please ask the librarian for access).

The maps are not catalogued on SOLO but the librarian has a database of what is held. Undergraduates are not allowed to borrow them but may use them during the librarian’s working hours. If they are required for longer, they may be used within the library by arrangement.

Tutorial Boxes

By the door to the library, on bookcase L-20, there are box files containing copies of articles provided by some tutors - they include articles that are often quoted or that are difficult to obtain. They are arranged by year (and by tutor in a few cases).

Exam Papers

Past examination papers are on OXAM. You will need your single sign-on to access it via WebLearn.

Mapping Reports

These can be found in a collection of files on bookcase L-20. They contain a collection of questionnaires about areas mapped in previous years by 2nd year undergraduates. These are arranged by country, and include maps as well as practical hints and tips that are invaluable for planning mapping projects. These are the only copies and must not be taken out of the library.

4th Year Projects

Copies of the final projects submitted by 4th Year students are kept in the Confined Cupboard and should be consulted in the same way as the books held there.

Worldwide geology

There is a good - if assorted - collection of material on the geology of countries throughout the world, such as Australia, Canada and various areas of Africa. This material has not yet been catalogued and is kept in the basement. Access is available upon request.

Photocopying

There are no photocopying facilities in the Library but Undergraduates may use the photocopier which is located behind the reception desk. It costs 5p per page.
Printing
Printing in the department can only be done in the Undergraduate Computing Lab. It is advisable to have a memory stick with you in the library to enable you to download any papers that you find while working there so that you can print them later.

Inter-library Loans
These are arranged through the Radcliffe Science Library. Please ask the librarian for forms. There are also payment tokens available to postgraduates and academics.

There are few rules for the library but they are intended for the benefit of everyone. Guidelines for using the library are as follows:

- The library is a quiet study area.
- Please do not bring any food or milky/sugary drinks into the library at any time.
- Please do not leave any personal belongings on the desks. They will be collected on a regular basis so that all users have free access. There are slots by the Atlases/Outsize material if storage space is needed during lectures.
- If you think you are the last person to leave the library, please switch off the lights!

Above all else, please do not hesitate to ask the librarian for help if you require it.

The Bodleian Libraries
Students also have access to the Bodleian Libraries, including the Radcliffe Sciences Library, and will also have access to college library facilities.

Elizabeth Crowley
Departmental Librarian

Telephone: (2)72050
Email: library@earth.ox.ac.uk
Appendix 7 - ACADEMIC INTEGRITY: PLAGIARISM AND GOOD PRACTICE IN CITATION

Plagiarism is presenting someone else’s work or ideas as your own, with or without their consent, by incorporating it into your work without full acknowledgement. All published and unpublished material, whether in manuscript, printed or electronic form, is covered under this definition.

Plagiarism may be intentional or reckless, or unintentional. Under the regulations for examinations, intentional or reckless plagiarism is a disciplinary offence.

Cases of suspected plagiarism in assessed work are investigated under the disciplinary regulations concerning conduct in examinations. Intentional or reckless plagiarism may incur severe penalties, including failure of your degree or expulsion from the university. The prohibition of plagiarism applies to all forms of set work, such as in tutorials or practicals. Plagiarism in tutorial work will be dealt with under your college’s disciplinary code, with which you need to be familiar.

Plagiarism is a breach of academic integrity. It is a principle of intellectual honesty that all members of the academic community should acknowledge their debt to the originators of the ideas, words, and data which form the basis for their own work. Passing off another’s work as your own is not only poor scholarship, but also means that you have failed to complete the learning process. Deliberate plagiarism is unethical and can have serious consequences for your future career; it also undermines the standards of your institution and of the degrees it issues.

Plagiarism can take the following forms:

a) Verbatim quotation of other people’s intellectual work without clear acknowledgement. Quotations must always be identified as such by the use of either quotation marks or indentation, with adequate citation. It must always be apparent to the reader which parts are your own independent work and where you have drawn on someone else’s ideas and language.

b) Paraphrasing the work of others by altering a few words and changing their order, or by closely following the structure of their argument, is plagiarism because you are deriving your words and ideas from their work without giving due acknowledgement. Even if you include a reference to the original author in your own text you are still creating a misleading impression that the paraphrased wording is entirely your own. It is better to write a brief summary of the author’s overall argument in your own words than to paraphrase particular sections of his or her writing. This will ensure you have a genuine grasp of the argument and will avoid the difficulty of paraphrasing without plagiarising. You must also properly attribute all material you derive from lectures.

c) Cutting and pasting from the Internet. Information derived from the Internet must be adequately referenced and included in the bibliography. It is important to evaluate carefully all material found on the Internet, as it is less likely to have been through the same process of scholarly peer review as published sources.

d) Professional agencies. You must neither make use of professional agencies in the production of your work, nor submit material that has been written for you. This course of action would be one of the most serious breaches possible of the rules on plagiarism. It is also vital to your intellectual training and development that you should undertake the research process unaided.

e) Collusion. This can involve unauthorised collaboration between students, failure to attribute assistance received, or failure to follow precisely regulations on group work projects. It is your responsibility to ensure that you are entirely clear about the extent of collaboration permitted, and which parts of the work must be your own.

f) Inaccurate citation. It is important to cite correctly, according to the conventions of your discipline. Additionally, you should not include anything in a footnote or bibliography that you have not actually consulted. If you cannot gain access to a primary source you must make it clear in your citation that your knowledge of the work has been derived from a secondary text (e.g. Bradshaw, D. Title of book, discussed in Wilson, E., Title of book (London, 2004), p. 189).

g) Failure to acknowledge. You must clearly acknowledge all assistance that has contributed to the production of your work, such as advice from fellow students, laboratory technicians, and other external sources.
h) Autoplagiarism. You must not submit work for assessment which you have already submitted (partially or in full) to fulfil the requirements of another degree course or examination.

The necessity to reference applies not only to text, but also to other media, such as computer code, illustrations, graphs, etc. It applies equally to published text drawn from books and journals, and to unpublished text, whether from lecture handouts, theses or other students' essays. You must also attribute text or other resources downloaded from web sites.

The University employs a series of sophisticated software applications to detect plagiarism in submitted examination work, both in terms of copying and collusion. It regularly monitors on-line essay banks, essay-writing services, and other potential sources of material. It reserves the right to check samples of submitted essays for plagiarism. Although the University strongly encourages the use of electronic resources by students in their academic work, any attempt to draw on third-party material without proper attribution may well attract severe disciplinary sanctions.

For further information see:

http://www.ox.ac.uk/students/academic/guidance/skills/plagiarism

http://www.ox.ac.uk/students/academic/guidance/skills
Complaints and academic appeals within the Department of Earth Sciences

The University, the Division of Mathematics, Physical and Life Sciences and the Department of Earth Sciences all hope that provision made for students at all stages of their course of study will result in no need for complaints (about that provision) or appeals (against the outcomes of any form of assessment).

Where such a need arises, an informal discussion with the person immediately responsible for the issue that you wish to complain about (and who may not be one of the individuals identified below) is often the simplest way to achieve a satisfactory resolution.

Many sources of advice are available from colleges, faculties/departments and bodies like the Counselling Service or the Oxford SU Student Advice Service, which have extensive experience in advising students. You may wish to take advice from one of those sources before pursuing your complaint.

General areas of concern about provision affecting students as a whole should be raised through Joint Consultative Committees or via student representation on the faculty/department’s committees.

Complaints

If your concern or complaint relates to teaching or other provision made by the faculty/department, then you should raise it with Director of Undergraduate Studies (Professor Hauke Marquardt) or with the Chair of Faculty (Professor Conall MacNiocaill). Complaints about departmental facilities should be made to the Departmental Administrator (Ian Wright). If you feel unable to approach one of those individuals, you may contact the Head of Department (Professor Chris Ballentine). The officer concerned will attempt to resolve your concern/complaint informally.

If you are dissatisfied with the outcome, you may take your concern further by making a formal complaint to the Proctors under the University Student Complaints Procedure (https://www.ox.ac.uk/students/academic/complaints).

If your concern or complaint relates to teaching or other provision made by your college, you should raise it either with your tutor or with one of the college officers, Senior Tutor, Tutor for Graduates (as appropriate). Your college will also be able to explain how to take your complaint further if you are dissatisfied with the outcome of its consideration.

Academic appeals

An academic appeal is an appeal against the decision of an academic body (e.g. boards of examiners, transfer and confirmation decisions etc.), on grounds such as procedural error or evidence of bias. There is no right of appeal against academic judgement.

If you have any concerns about your assessment process or outcome it is advisable to discuss these first informally with your subject or college tutor, Senior Tutor, course director, director of studies, supervisor or college or departmental administrator as appropriate. They will be able to explain the assessment process that was undertaken and may be able to address your concerns. Queries must not be raised directly with the examiners.

If you still have concerns you can make a formal appeal to the Proctors who will consider appeals under the University Academic Appeals Procedure (https://www.ox.ac.uk/students/academic/complaints).
None of us are superhuman. If things are getting too much for you and you feel you can’t cope, ask for help.

Good mental health for all.
The University condemns Harassment* as an unacceptable form of behaviour, and has a service to help staff and students who think that they are being harassed in any way.

**What can you do?**

1. You can talk to your supervisor/line manager or one of the Departmental Harassment Advisers:
   - Helen Johnson  
   Tel: 72142
   - Conall MacNicoall  
   Tel: 82135
   - Emma Brown  
   Tel: 72043
   - Jamie Long  
   Tel: 72060
   - Claire Rylatt  
   Tel: 72040

2. Contact the University’s confidential Harassment Line and ask for a referral to someone outside the Department:  
   Tel: (2)70760    Email: harassment.line@admin.ox.ac.uk

3. Talk to the OUSU Student Advice Service:  
   Tel: (2)88466    Email: advice@ousu.org

* A person subjects another to harassment when they engage in unwanted/unwarranted conduct which has the purpose or effect of:
  - violating another person’s dignity, or
  - creating an intimidating, hostile, degrading, humiliating or offensive environment for another person.

The recipient does not need to have explicitly stated that the behaviour was unwanted.

For further advice on dealing with harassment visit: www.admin.ox.ac.uk/eop/harassmentadvice
Appendix 11 - THE LINKS BETWEEN RESEARCH AND TEACHING

The Department of Earth Sciences has an international reputation for its research profile, and there are many benefits to the processes of teaching and learning that follow from this high level of research activity. All of the tutors and lecturers with whom you will interact over the duration of your course are employed not only to teach you, but are also actively engaged in research. Many of the individual academic staff in the department are known internationally as leaders in their own specialist fields.

The impact that this research has on teaching takes many forms - ranging from the introduction of new ideas into lectures, practical and field classes and tutorials, to the opportunities that you will have to engage in research in the fourth year of the course. In turn, teaching also has an impact on our research. Nothing exposes the weakness of an idea or an argument quite as much as when you have to explain it to an audience, as you will find out in tutorials and seminars throughout the course.

The article below, which was written by Philip England, explains the way that field work, in particular, helps to build the relationships between students and lecturers in the department.

Earth Science students experience particularly informal social and working relationships with academics, rooted in the nature of field work that gradually includes them into the scholarly community.

The core aspect of Oxford undergraduate teaching is close contact between the student and people engaged in research at the highest international level, and that contact is often identified with the traditional one-on-one or two-on-one tutorial. The purpose of this article is to describe the interactions within a small science department, and to suggest that there are additional routes towards the same quality of experience.

Earth Science is, to first order, not taught in schools, and most applicants to our undergraduate course have been attracted to the subject through their individual curiosity about some aspect of geology - earthquakes, volcanoes, evolution of life, and the origin of the solar system are common examples. The goal of our course is to give students the analytical and observational apparatus to convert that curiosity into an effective tool for investigation of the (always inextricably interlinked) physical, chemical, and biological processes that govern the evolution and present state of the planet upon which we live. When we discuss how we try to achieve this goal we rarely discuss teaching strategies or learning outcomes, because we regard the undergraduate experience as more akin to an apprenticeship than to four years of formal teaching.

Fieldwork is a central aspect of Geology and, almost irresistibly, it imposes a flavour upon our teaching. In a tutorial, even with the most able students, the tutor always has some element of control: topics can be specified, limits of discussion can be defined and, if all else fails, one can escape at the end of the hour. A day in the field typically involves more than 12 hours of close-contact teaching, in which the agenda is set by the observations that the students make, and the questions that they pose. Frequently, those questions have no known answer. Even if one wished to claim Olympian omniscience, that bubble would be pricked by the unexpected or inexplicable observation; there is no place to hide. The nature of field teaching forces the teacher to treat the experience as a collaborative enterprise in interpretation of the aftermath of Nature’s experiments, rather than as the transfer of received wisdom from the old to the young.

It is also the case that ties between students and their college tutors remain strong. Earth Sciences is a very diverse discipline, and undergraduates reflect the interests of their tutors to a greater degree than is explicable by pure chance. However, because the undergraduates know the personalities and interests of the academic staff they can make informed choices about the route through their education and by the time they embark on their 4th-year research project, they are usually grappling with a problem in which they have a close personal interest. We believe that an environment that minimizes the barriers between staff and students is essential if our students are to effect the transition from the memory-driven toils of A-level to free-standing members of the research community.
Appendix 12 - MOONCUP, WUKA AND SHEWEE DISCOUNT CODES

In an effort to provide more options for dealing with periods, particularly in the field, we’ve negotiated discounts on two of the main UK producers of menstrual cups (Mooncup) and period underwear (WUKA).

The **WUKA discount code** provides 10% off, and will run indefinitely:

https://wuka.co.uk/
Code: EARTH10

The **Mooncup discount code** provides 20% off, and will run during October - December 2019 only:

https://www.mooncup.co.uk/
Code: EARTHOX

We have also negotiated a 50% discount for the **ShePee Extreme**, in case this is of help to women in the field:

https://www.shewee.com/she-pee-extreme.html
Code: OXFORDUNI

These codes are only for members of the department, so please do not share them.

Of course other options are available, and please contact emma.brown@earth.ox.ac.uk if you have any suggestions for other companies we should approach.
Appendix 13 - COTSWOLD OUTDOORS DISCOUNT

15% DISCOUNT
FOR STUDENTS + STAFF OF THE UNIVERSITY OF OXFORD
DEPARTMENT OF EARTH SCIENCES

IN-STORE AND ONLINE
Online code: AF-OXDES-S7

COTSWOLDOUTDOOR.COM | SNOWANDROCK.COM | CYCLESURGERY.COM | RUNNERSNEED.COM

Full T&Cs apply. Not to be used in conjunction with any other off or online discount. Selected lines are exempt. 17% discount only on bikes. Only valid upon production of your membership identification in store or use of valid discount code online. Offer expires 31.10.19.