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| **Academic Year** | 2020/2021 | **Semester** | 2 |
| **Course Coordinator** | Aron Meltzner | | |
| **Course Code** | ES1003 | | |
| **Course Title** | E2S2: Solid Earth | | |
| **Pre-requisites** | None | | |
| **No of AUs** | 4 | | |
| **Contact Hours** | Lectures: 12 × 3 hours = 36 hours<br>Lab: 7 × 4 hours = 28 hours<br>Online Modules: 2 × 6 hours = 12 hours<br>Field Trips: 2 × 6 hours = 12 hours<br>Final Report and Final Review: 12 hours<br>TOTAL: 100 hours | | |
| **Proposal Date** | 16 December 2020 | | |

**Course Aims**

This introductory course aims to provide a broad overview of physical geology, with an emphasis on the materials that make up the solid earth and the physical processes by which these materials are accumulated and transformed. These geological processes operate over a wide range of time scales. For example, earthquakes last only seconds, but over millions of years they result in mountain building. We will explore these processes, the concept of geologic time, and the ways that geologists learn about the earth and earth processes, so that you can begin thinking as an earth scientist.

**Intended Learning Outcomes (ILO)**

By the end of this course, you should be able to:

1. explain fundamental earth science concepts and principles using words and sketches
2. use Google Earth and Google Maps to identify, locate, measure, and relate geological features, and to observe global change
3. infer processes that led to the formation of a rock, an outcrop, or a landform, based on its properties
4. integrate geological observations with process to reconstruct a site's geological history

**Course Content**

This course is designed to give a broad overview of the basic concepts of physical geology.
We will move from one topic to another in a logical progression. Content will cover the following:

Formation of the Solar System; Plate Tectonics; Earthquakes and Tsunamis; Crustal Deformation and Isostasy; Minerals and Crystals; Magmas and Igneous Rocks; Volcanoes and Volcanic Eruptions; Sedimentary Rocks and Geologic Time; Coastal Processes and Landforms; Metamorphic Rocks and Mountains; Glaciers and Global Change; Earth Resources; and Hydrological Cycle, Streams & Rivers, and Groundwater.

**Assessment (includes both continuous and summative assessment)**

| Component | ILO Tested | Related Programme LO or Graduate Attributes | Weighting | Team/Individual | Assessment Rubrics |
|---|---|---|---|---|---|
| 1. Lab Assignments | 1, 2, 3, 4 | Communication, Lifelong Learning | 20% | Teamwork okay but write-ups must be Individual | Appendix 1 |
| 2. Online Modules + Excursion Follow-Up | 1, 2, 3, 4 | Communication, Lifelong Learning | 20% | Teamwork okay but write-ups must be Individual | Appendix 1 |
| 3. Class Quizzes | 1, 3, 4 | Communication, Lifelong Learning | 10% | Individual | Appendix 1 |
| 4. Midterm Test | 1, 3, 4 | Communication, Lifelong Learning | 10% | Individual | Appendix 1 |
| 5. Final Test | 1, 3, 4 | Communication, Lifelong Learning | 30% | Individual | Appendix 1 |
| 6. Final Report | 1, 2, 3, 4 | Communication, Lifelong Learning | 10% | Individual | Appendix 2 |
| Total | | | 100% | | |

**Formative feedback**

Following **lab assignments**, you will receive direct written feedback, normally within two weeks. In this way the lecturer and you can monitor your progress.

The two **online modules** are essentially preparation for the two field excursions. You will receive direct feedback on each online module prior to the corresponding field excursion. In that way, during the actual field excursion, you will be able to reinforce any concepts you are weak on.

Weekly **class quizzes** will be exchanged and graded by your peers immediately upon completion; as part of this process, you will get to see the rubric and you will know immediately how you did.

Following the **midterm test**, you will receive direct written feedback, normally within two weeks. In this way the lecturer and you can monitor your progress.

**Learning and Teaching approach**

| Approach | How does this approach support you in achieving the learning outcomes? |
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| Lecture | Lectures will pass on the theoretical knowledge required to understand the various concepts. |
| Lab | Labs will allow students to apply theoretical knowledge learned in lecture; to learn additional concepts from first principles; and to practice using basic tools, techniques, and methods of earth science. |
| Field excursion | Field trips will be similar to labs but will add valuable experience by getting students to apply knowledge and solve problems in the 'real world'. They will also get students to relate the 'real world' to imagery in Google Maps. |

**Reading and References**

Each week you should read the relevant chapters from:
*Essentials of Geology* by Stephen Marshak (Fourth Edition or later), W.W. Norton & Company.
ISBN 0393263398 or 0393667529
http://amzn.com/0393263398 or http://amzn.com/0393667529

**Course Policies and Student Responsibilities**

(1) General

You are expected to attend all lectures, labs, and field trips, and to show up on time.

Two of the lab periods are designated as online modules. Attendance for these is optional but encouraged, as the instructor and TA(s) will be on hand to provide support and answer questions. If you intend to attend the online modules in person, bring a laptop and earphones on those days, or discuss alternative arrangements in advance with the instructor or TA(s).

Since we have a lunchtime time slot it is ok to eat during lectures, as long as you bring food that is quiet to eat, not too messy, and you remove all litter and leave the classroom spotless. It is not ok to eat while working in the computer lab, or while handling lab specimens and equipment.

(2) Absenteeism

Absence from class without a valid reason will affect your overall course grade.
Valid reasons include falling ill supported by a medical certificate.

If you need to miss a class due to an emergency or illness, please notify the course instructor via e-mail as soon as possible and we can discuss how to accommodate the missed class.

(3) Due Dates

Late assignments will receive 10% deducted from the final score for every day that they are late, unless the student has an approved reason that has been agreed upon by the instructor.
After the fourth day of being overdue, the assignment will receive a zero score.

(4) Quizzes

The weekly quizzes will take place at the start of lecture. These will contain multiple-choice and short-answer questions related to the material covered the previous week. They may also contain 1 or 2 questions on the material about to be covered, so doing the required reading in advance of the lectures is necessary. If you do not show up, you will miss the quiz. Notify the instructor in advance if you have a valid reason for missing the quiz, so that we can arrange a makeup.

(5) Contacting the Instructors/ Office Hours

We are busy people. We would prefer that you do not e-mail us directly with questions. Only email us directly if you have personal concerns or issues with missing classes. If you do need to email, do it professionally: use your academic account; use a meaningful subject line; use full formatting with a greeting, message body, and signature with full name; do not use SMS-style abbreviations; and proof-read it before you hit send. Do not expect an immediate response.

If you have a question that the whole class would benefit from (this is usually the case!) please ask the question in class. We will make sure you get plenty of opportunities to ask questions.

If you still have questions, please post your question on the NTULearn discussion board. We will either answer the question there, answer the question in the next class/lab, or set up a time to meet you in person for discussion. Please do not be shy about posting questions on the board —many other people are likely to have the same question, and learning to publicly ask questions is a very necessary skill for success in your career.

(6) Academic Integrity

We take plagiarism, cheating, and other breaches of academic integrity very seriously, and these will likely result in a failing grade for the assignment or even the course. Please know the rules and consequences as defined in the NTU policy document on academic integrity (http://www.ntu.edu.sg/ai/Pages/academic-integrity-policy.aspx).

Some portions of labs are designed to be done in pairs or groups, while others are intended to be done individually. Sometimes you can work and submit as a group. Other times, you may *talk* to your fellow students about the lab, but your submitted assignment must reflect *only* your own contributions and work. Make sure you understand the specific rules for group versus individual contributions for each labor assignment. If you are unsure, ask!

Many of our labs are designed to develop your detective skills, requiring you to figure things out yourself using your own background knowledge and intuition. Use of Google when doing lab assignments is only allowed if specifically stated by the instructor. If you are not sure, ask!

**Academic Integrity**

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values

shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

**Course Instructors**

| Instructor | Office Location | Phone | Email |
|---|---|---|---|
| Asst Prof Aron Meltzner | N2-01a-05 | 6592 2403 | meltzner@ntu.edu.sg |
| Assoc Prof Emma Hill | N2-01c-48 | 6592 1603 | ehill@ntu.edu.sg |

**Planned Weekly Schedule**

| Week | Topic | ILO | Readings/ Activities |
|---|---|---|---|
| 1 | Formation of the Solar System | 1 | Prelude; Chapter 1 |
| 2 | Plate Tectonics | 1,2 | Chapter 2; Interlude D |
| 3 | Earthquakes and Tsunamis | 1,2 | Chapter 8 |
| 4 | Crustal Deformation and Isostasy | 1,2 | Chapter 9 |
| 5 | Minerals and Crystals | 1 | Chapter 3 |
| 6 | Magmas and Igneous Rocks | 1,3 | Interlude A; Chapter 4 |
| 7 | Volcanoes and Volcanic Eruptions | 1,2,3,4 | Chapter 5 |
| 8 | Sedimentary Rocks and Geologic Time | 1,2,3,4 | Interludes B, C; Chapters 6, 10 |
| 9 | Coastal Processes and Landforms | 1,2,3,4 | Chapter 15 |
| 10 | Metamorphic Rocks and Mountains | 1,2,3,4 | Chapter 7 |
| 11 | Glaciers and Global Change | 1,2,3,4 | Chapters 18, 19 |
| 12 | Earth Resources | 1,2 | Chapter 12 |
| 13 | Hydrological Cycle, Streams & Rivers, and Groundwater | 1,3 | Interlude F; Chapters 14, 16 |

**Appendix 1: Assessment Criteria for Open-Ended (Free-Response) Questions on Lab Assignments, Online Modules, Excursion Follow-Up, Quizzes, and Tests**

| Standards | Criteria |
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| Far exceeds expectations | When asked to "explain" something:<br>Responses should briefly describe the most relevant facts, observations, theories, and/or processes, and then logically relate them to one another and synthesize them in order to formulate inferences that are based on evidence and reasoning.<br><br>When asked for a sketch:<br>Sketches should be clear, sufficiently detailed, clearly labeled, and, where requested, integrated into a textual description to answer the question. Where appropriate, to stress the key details, aspects, components, or factors, the primary sketch may be accompanied by a counterexample, showing how things would be different in different circumstances.<br><br>When appropriate to use Google Earth or Google Maps (*after* Lab 1*):<br>Responses should effectively and correctly incorporate information from Google Earth or Google Maps, demonstrating thorough comprehension of the relationship between geospatial imagery or data, and the real world or real-world processes. |
| Exceeds expectations | When asked to "explain" something:<br>Responses describe most of the relevant facts, observations, theories, and/or processes, and then logically relate them to one another and synthesize them in order to formulate inferences that are based on evidence and reasoning.<br><br>When asked for a sketch:<br>Sketches are clear, sufficiently detailed, clearly labeled, and, where requested, integrated into a textual description to answer the question, but there may be gaps in the explanation.<br><br>When appropriate to use Google Earth or Google Maps (*after* Lab 1*):<br>Responses incorporate information from Google Earth or Google Maps, demonstrating a basic comprehension of the relationship between geospatial imagery or data, and the real world or real-world processes, but some of the information drawn from Google Earth or Google Maps may be incomplete or not used in an entirely effective manner, or may contain minor inaccuracies. |

* You will learn about Google Earth, geospatial imagery, and geospatial data in Lab 1. During Lab 1, follow the guidance in the lab itself and do not worry about the expectations laid out in this rubric.

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| Meets expectations | <u>When asked to "explain" something:</u><br>Responses describe most of the relevant facts, observations, theories, and/or processes, and then relate them to one another in order to formulate inferences, but any logical reasoning is not fully developed.<br><br><u>When asked for a sketch:</u><br>Sketches are clear, somewhat detailed, labeled, and, where requested, integrated into a textual description to answer the question, but a few details may be missing, and there may be gaps in the explanation.<br><br><u>When appropriate to use Google Earth or Google Maps (*after* Lab 1*):</u><br>Responses incorporate information from Google Earth or Google Maps to support a broader answer, but the information is incomplete and not used entirely effectively; some of the information from Google Earth or Google Maps may contain minor inaccuracies. |
| Below expectations | <u>When asked to "explain" something:</u><br>Responses describe some of the relevant facts, observations, theories, and/or processes, but do not appropriately relate them to one another or formulate valid, supported inferences.<br><br><u>When asked for a sketch:</u><br>Sketches are insufficiently detailed or labeled, and responses rely mostly on words instead of the sketches, or there are gaps in the explanation.<br><br><u>When appropriate to use Google Earth or Google Maps (*after* Lab 1*):</u><br>Responses incorporate information from Google Earth or Google Maps but miss some of the most important or relevant details, or some key features were misidentified, misinterpreted, mislocated, or mismeasured. But on the whole, enough information from Google Earth or Google Maps is correct and used appropriately that it is helpful to the overall answer. |
| Far below expectations | <u>When asked to "explain" something:</u><br>Responses get most of the facts, observations, theories, and/or processes wrong, or omit most of them.<br><br><u>When asked for a sketch:</u><br>Sketches are not relevant, or are so poorly detailed, labeled, or explained as to be ambiguous and ineffective in answering the posed question.<br><br><u>When appropriate to use Google Earth or Google Maps (*after* Lab 1*):</u><br>Responses do not include information from Google Earth or Google Maps, or the information is generally incorrect, or the information is not used in a way that supports the correct answer. |

**Appendix 2: Assessment Criteria for Final Report**

| Standards | Criteria |
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| Far exceeds expectations | The writer carefully describes key observations from the class field trips, and then uses those observations to infer the processes that led to the formation of the rocks, outcrops, and landforms seen on those field trips. The writer then integrates key observations from both field trips and from Google Earth with inferences about process, in order to reconstruct the geological history of Singapore on the timescales of the rocks observed on the field trips. The report clearly explains concepts and principles, and uses sketches and figures effectively. |
| Exceeds expectations | The writer carefully describes key observations from the class field trips, and then uses those observations to infer the processes that led to the formation of the rocks, outcrops, and landforms seen on those field trips. The writer then integrates observations from both field trips and from Google Earth with inferences about process, in an attempt to reconstruct the geological history of Singapore, but the Google Earth observations are limited or not used effectively, and the reconstructed geological history may be incomplete, or not fully supported by observations. The report uses sketches and figures, but not always effectively. |
| Meets expectations | The writer carefully describes key observations from the class field trips, and then makes inferences about processes that led to the formation of the rocks, outcrops, and landforms seen on those field trips, but the inferences are not always related to or supported by the observations. The writer presents a geological history of Singapore that may be credible, invoking observations from both field trips and from Google Earth, but the Google Earth observations are limited and ineffective, and the proposed history is incomplete and not adequately supported by observations. The report relies primarily on words, using sketches sparingly. |
| Below expectations | The writer describes observations but those descriptions are incomplete, and the writer struggles to make inferences about the processes involved. If the writer proposes a geological history of Singapore, it is mostly or entirely unsupported by descriptions of observations. If Google Earth observations are incorporated, those observations are inaccurate, irrelevant, limited, or not used effectively. The report relies primarily on words, using sketches sparingly, and the sketches that are used do not offer much support to the reader. |
| Far below expectations | The writer has difficulty describing observations from the sites, and any inferences about process are flawed. If Google Earth observations are incorporated, those observations are inaccurate, irrelevant, limited, or not used effectively. Sketches, if any, are unhelpful. |