

EOSC 114 – The Catastrophic Earth: Natural Disasters



Photos: Karen Kasmauski; [/news.discovery.com/earth/volcano-ecuador-guatemala.html](https://news.discovery.com/earth/volcano-ecuador-guatemala.html); Brett Gilley; flickr user [mrpbps](#); USGS; NASA

Intentional arrival

- Aim to be on time (we know campus is large!)
- Sit down and say Hi – make friends and influence people
- Make a quick “to do” list from your previous class/day
- Log on to your iClicker app
- Send that last important text then turn your notifications off – be ready to be intentional in your learning
- Download pdf of notes before class, and annotate/make your own notes
- Ask questions!

Today

Welcome and Introductions

Teaching Team and Topics

Course Goals

Disaster info you need

About the course

Background Information

Introductions... You

Take out a blank piece of paper

Write down your name

And

One thing that people might not guess
just by looking at you

A Fragile System?

Nat.Dis./Rare Events

- measuring our earth
- disaster frequency
- hazard vs. risk

Materials

- characteristics

Energy

- types of energy
- build-up / release
- conversions

Is Earth Fragile?

- population
- humans vs. earth



Lucy Porritt

Also the course Administrator

The Turbulent Atmosphere

Doug McCollor

Thunderstorms

- hail, lightning
- downbursts
- gust fronts
- storm energy

Tornadoes

Hurricanes

Fields

- meteorology
- atmospheric sci.



Photo: flickr user [mrpbps](#) [CC License](#)

The Violent Ocean

May Ver

Waves

How they work:

water, waves, energy

Destructive Ocean Waves

- storm surge
- tsunami
- seiche
- rogue waves

Waves on Shorelines

- erosion
- longshore drift
- mitigation

The Future...

Fields

- oceanography

Photo: National Geographic





The Shaking Earth

Simon Peacock

Earthquakes

- global distribution, plate tectonics
- local effects, Cascadia

Earthquake Sources

- tectonic forces, rock deformation
- faults, stress

Seismic Energy

- ground motion, wave types
- seismic waves

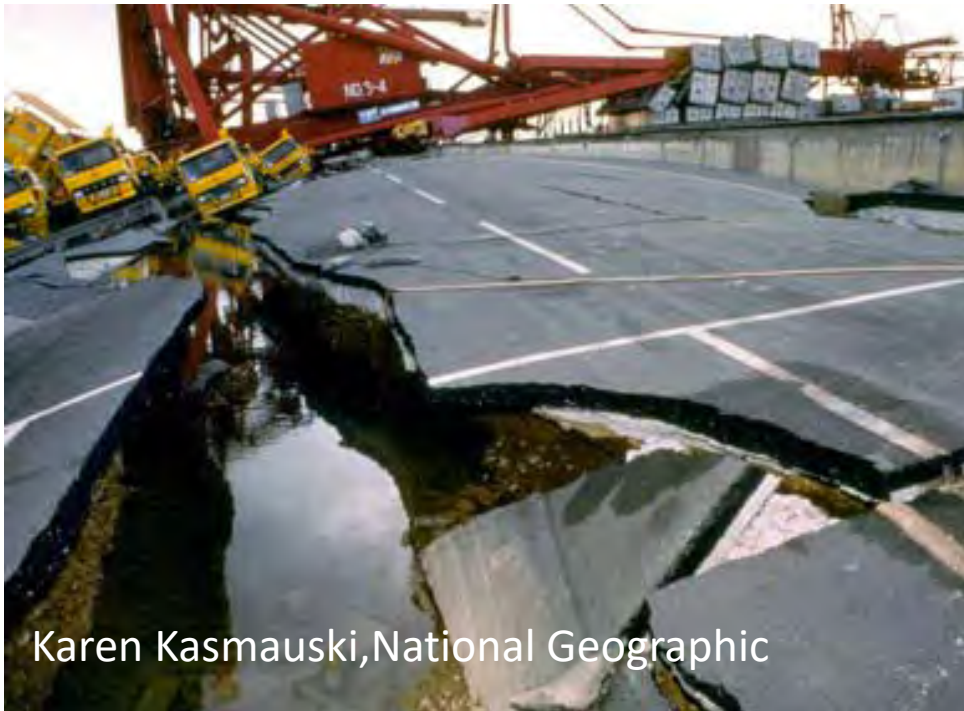
Human Impact Engineering

- earthquakes don't kill...
- ground motion, building motion

Mitigation & Forecasting

Fields

- geology, geophysics, seismology



Karen Kasmauski, National Geographic

The Unstable Ground

David Sasse

Landslides

- socioeconomic impacts
- types of mass movements
- causes - triggers - effects
- slope stability: shear strength vs stress
- case studies, BC issues, liquefaction
- investigation, prevention, mitigation

Fields

- geological engineering
- hydrology, glaciology

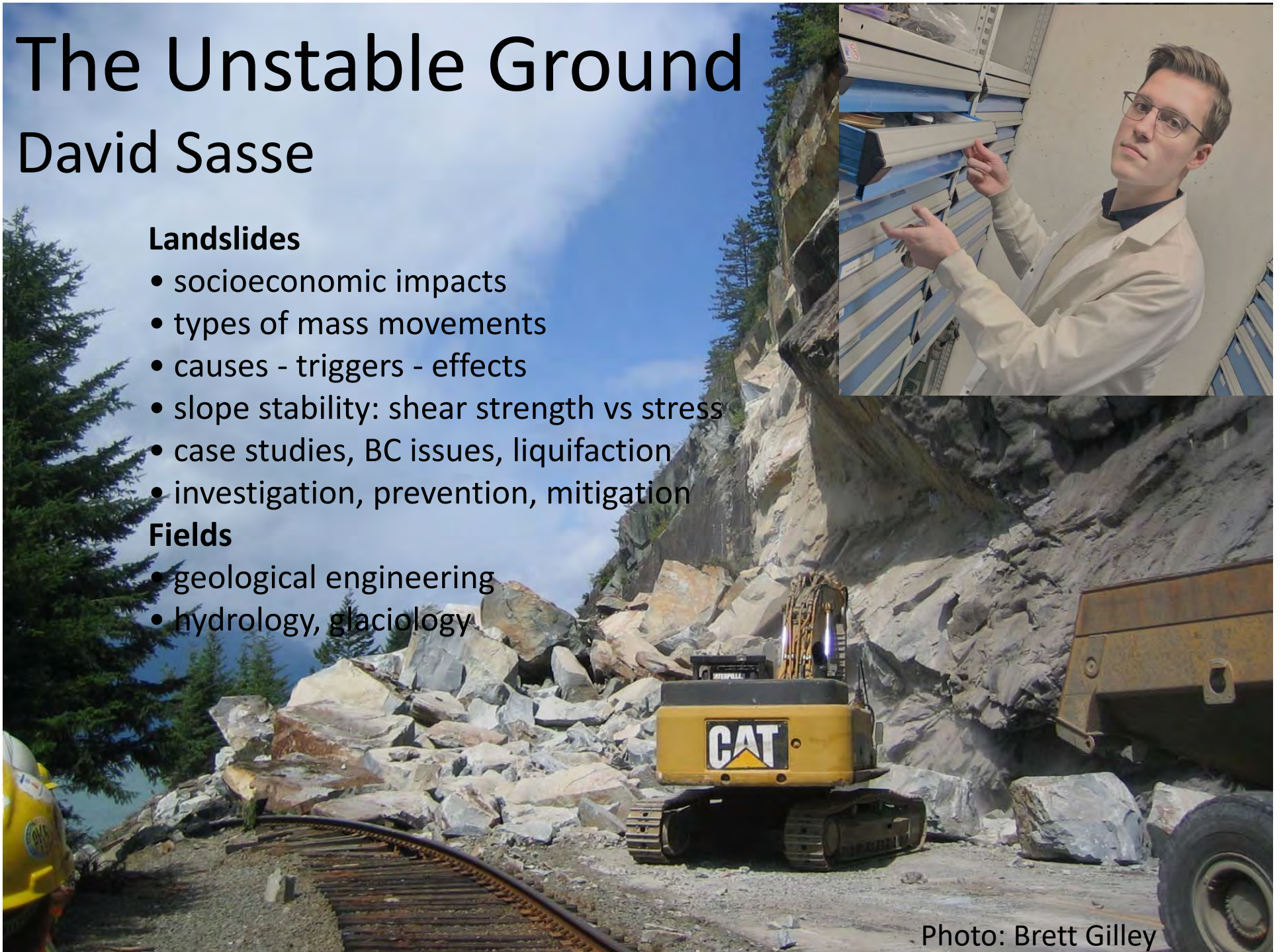


Photo: Brett Gilley

The Explosive Earth

David Sasse

Volcanoes

- magma / lava properties
- eruptive products, landforms
- local volcanoes, case studies
- threats (lava, lahars, ash, pyroclastic flows, gases,...)
- monitoring, prediction
- plate tectonic setting

Fields

- geology, volcanology

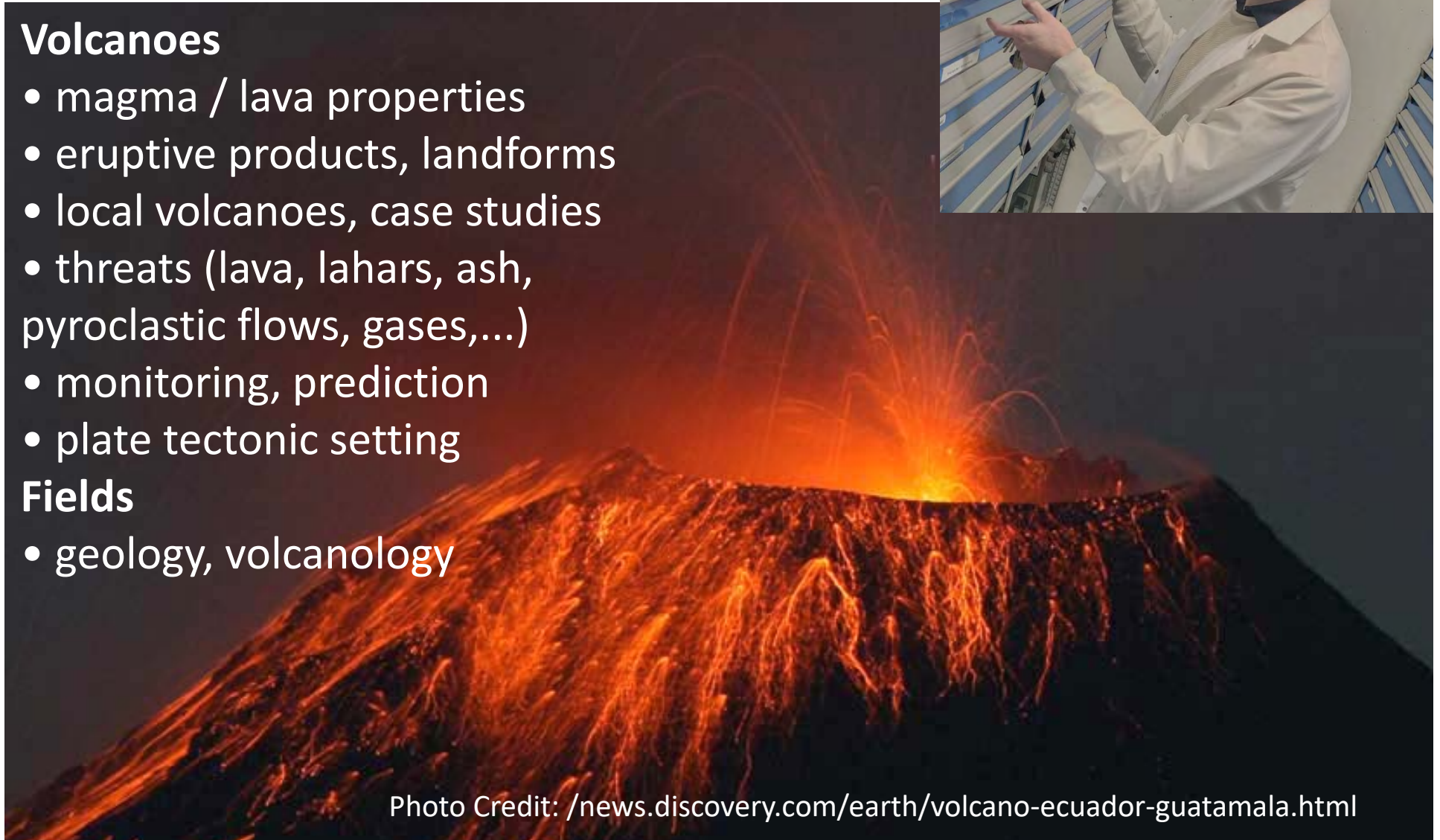


Photo Credit: [/news.discovery.com/earth/volcano-ecuador-guatamala.html](https://news.discovery.com/earth/volcano-ecuador-guatamala.html)



Impacts / Mass Extinctions

Mitch D'Arcy

Mass Extinctions

- biosphere evolution
- timelines, biostratigraphy
- biodiversity, fossils
- causes of mass extinction
- **K/P Event**
- dinosaur extinction
- Chicxulub

Meteorite Impacts

- asteroids & comets
- meteors, impact craters
- effects on humans

Fields

- paleontology,
- geochronology,
- biodiversity

A Fragile System? Part 2

Synthesis

- consolidate your understanding
- linkage of many disasters
- climate change connections

Application to You

- disaster scenario
- how you can prepare

Opportunities

- for further study

Lucy Porritt

Also the course Administrator



Not Every Disaster

Not Covered:

- Avalanches
- Forest Fires
- Heat/Cold Waves
- Blizzards
- Floods
- Pandemics

- Human-Caused Disasters
such as:
 - Climate Change (?)
 - War/Terrorism
 - Nuclear Winter
 - Other Disasters

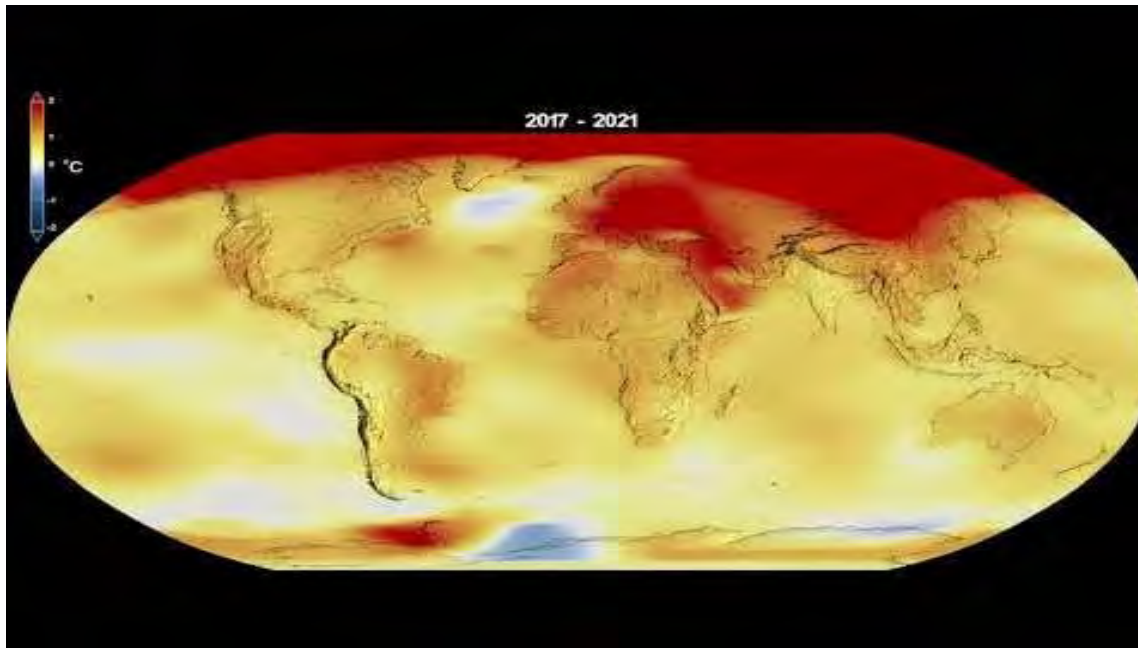
Photo Credit: Steve Devries

UBC Climate Emergency

<https://climateemergency.ubc.ca/>



- How is climate changing?
- What is causing the change?
- How will this change affect the frequency/intensity of our disasters?
- Do any of our disasters influence the climate?



<https://www.youtube.com/watch?v=haBG2IlbwbA&t=30s>

A comment on humour



WITH ALL OF THE DISASTERS IN THE WORLD TODAY

IT'S GOOD TO REMEMBER YOUR SENSE OF HUMOR

Why are we doing this?

- 2011 Tōhoku Earthquake and Tsunami
- 15,889 deaths,
- 6,152 injured,
- and 2,609 people missing



<http://www.youtube.com/watch?v=jBdvvXyS-r4&feature=related>

Course Goals

For meteor impacts, storms, waves, earthquakes, landslides and volcanoes you will:

- Describe how the natural disasters work.
- Locate the dangerous places where they have often occurred.
- Describe the ways scientists observe and monitor natural disasters.
- Explain why it is hard to forecast natural disasters.
- Describe what you and your community can do to prepare for natural disasters.
- Discuss how these natural disasters relate to human-induced climate change.

Course Goals

Your teaching team will strive to:

- Empower you to be a survivor.
- Enable you to approach new challenges insightfully.
- Sharpen your observations of nature.
- Stimulate your excitement in our planet.

iClickers

We will be using iClicker Cloud/Student:

- 4% Performance for question responses
- Your chance to “make mistakes”
- 2% BONUS!! For correct answers
- We will start recording iClicker marks in Storms next week
- Register your iClicker in the course using iClicker Cloud tab on the left hand menu in Canvas

<https://lthub.ubc.ca/guides/iclicker-cloud-student-guide/>

iClickers

We know that:

1. Some of you don't have your iclicker app yet.
2. Your device battery might die.
3. You might miss some classes.

Don't Panic.

iClickers – answer $\geq 80\%$ of all iClicker questions
and you will receive full performance marks

Some notes about Learning

- Lectures are live – no recordings
- Lectures are efficient
- Lectures aren't so great for retention
- You have to do something (activities /discussions)
- You will be working together
- Make notes in class – not everything is on the pdfs!

Some notes about Learning

- There is no gene for these topics
- Being wrong means you are learning
- Get comfortable with being wrong in class!
- (So you can be right in the exam!)
- Plan your own success
- Stay curious

Comment from past years

“... At first, I didn't agree with the interactive aspect of the lectures and exams; however, I realized it's vital to the understanding of the topics. As a naturally shy person, it was uncomfortable to accept this idea, but I'm glad I didn't switch to the hybrid version because I really feel it was a great experience.”

iClicker Question - Practice

Which one natural disaster has most affected you or your family?

(Or if none has affected you, which most worries you?)

A) Earthquakes or Tsunami

B) Volcanoes

C) Landslides

D) Storms

E) Meteor Impacts
(Mass Extinctions)

Discuss

- 1) Discuss which of our topics you are most interested in (Impacts, Storms, Waves, Earthquakes, Landslides, Volcanoes)
- 2) These are deadly disasters. What information do want to learn to help you survive this disaster.

Course Canvas Site

<https://canvas.ubc.ca/>



Includes:

- Learning Goals
- Lecture schedule
- Course notes
- Test schedule
- Homework
- Grades
- Sample Exam Qs
- and more

Have Questions?

- 1) Check your course materials
- 2) Use the general discussion board
- 3) Ask a TA – drop in office hours (TBD) or email
- 4) Course admin stuff (missed exams, etc.) contact the course administrator:

Lucy Porritt (me again!)

lporritt@eoas.ubc.ca

Course Evaluation

10% Midterm Exam 1 (September 25th)

10% Midterm Exam 2 (October 23rd)

10% Midterm Exam 3 (November 20th)

45% Final Exam (TBA) – exam dates released late October!!

ALL EXAMS ARE IN PERSON AND HAVE A GROUP COMPONENT

15% Assignments online reading/quizzes (average of top 5/7)

6% Class Map Project

4% iClicker Performance (responding)

2% iClicker Bonus (correct answers)

Course Evaluation

Assignment & Exam Dates

See Canvas and the course Syllabus

Test Topics – based on learning goals for the modules

- MT1 Fragile Systems and Storms
- MT2 Waves and Earthquakes
- MT3 Landslides and Volcanoes
- Final Exam – cumulative, slight emphasis on Impacts & Extinctions

Tests

- Multiple-choice, closed book, individual (85%) group (15%)

Homework

Reading Homework will consist of reading assignments for each topic – exposing you to a variety of scientific writing

Each homework will have an accompanying worksheet – work through this as you read the article, then there will be an online test based on the worksheet for you to submit by a specific date (see syllabus for deadlines).

Class Project – the class will contribute to a natural hazards map based on events you are interested in and/or have impacted you and your family.

Today's Learning Goals (FS1)

- a) Define what a disaster really is
- b) List the components of the atom.
- c) List the 1st, 2nd and 3rd most common elements in the earth, ocean, and atmosphere.
- d) List the metric prefixes and their values from Tera to Pico
- e) Explain what density is & how it relates to stratification.
- f) Define fluid, viscosity, and compressibility and how they relate to the phases of matter.

HOMEWORK – explore your background knowledge

What is a disaster?

Easy! Right?

Discuss

Disaster

Dis - Hard, bad, unlucky

Aster – Star (chief star or shooting star)

“Bad star” or “The stars are evil”

Disaster

Substantial event causing

- 1) physical damage,
- 2) injury or loss of life, and/or
- 3) a drastic change to
the environment

First Homework

Explore your background!

On Canvas – in Fragile Systems Module

1st Attempt due September 15th

Once it closes – you will be able to access some feedback, then have a second attempt due September 22nd – highest of these grades is taken.

What you should do next

Read the following background knowledge slides from today's class before Friday

Visit the course Canvas Site: <https://canvas.ubc.ca/>

- Download the syllabus and note dates/deadlines in your diary
- Get the iClicker App

Complete:

- Explore Your Background Assessment **By September 15th**
- Read the feedback on the homework posted **September 16th – drop in on our TA's if you need help (times TBD)**
- Try the Backgrounds quiz again after reading the feedback **by September 22nd**
- **Only the highest of these two attempts will count**

Things you need to know....

The following slides should be a refresher from some time in your distant past, or just things you should be comfortable with in this course.

****If you are unsure of anything, **anything at all** – drop in on our awesome TA's, they are there to support your learning – office hours TBD soon****

Matter

Elements: A chemical *element* consists of identical atoms.

Atoms: Protons (+) & neutrons in nucleus, Electrons (-) orbit.

Atomic #: The number of protons.

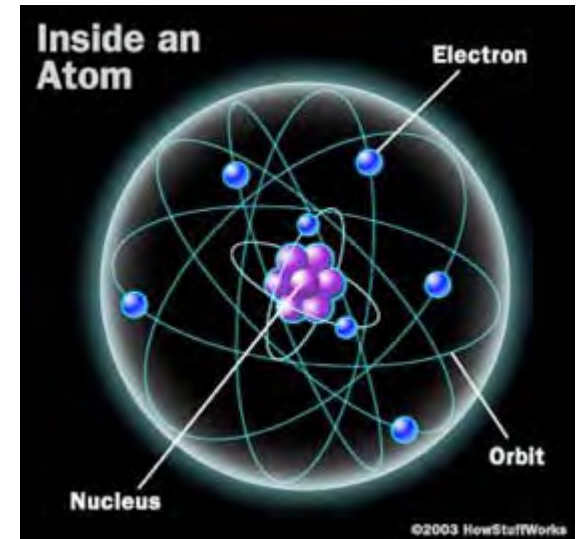
Atomic Mass #: The number of protons + neutrons.

Isotopes: Same element with same number of protons, but different numbers of neutrons.

- e.g. carbon12 (= 6 protons + 6 neutrons)
- vs. carbon14 (= 6 protons + 8 neutrons)

• **Molecules** - Combinations of atoms. Neutral charge.

• **Ions** - Incomplete combinations of atoms. Have charge. e.g.: silicate (SiO_4)⁻⁴



Earth Materials

Abundance by Mass	Earth Core	Earth Crust	Ocean	Atmos.
Most	iron	oxygen	oxygen	nitrogen
2nd	Nickel	silicon	hydrogen	oxygen
3rd	Oxygen?	aluminum	chlorine	argon

Some Elements mentioned in this Course (Don't memorize the list below, just the table above):

Hydrogen (H), Helium (He) , Carbon (C), Nitrogen (N), Oxygen (O), Sodium (Na), Magnesium (Mg), Aluminum (Al), Silicon (Si), Phosphorus (P), Sulphur (S), Chlorine (Cl), Argon (Ar), Potassium (K), Calcium (Ca), Titanium (Ti), Manganese (Mn), Iron (Fe), Nickel (Ni), Iridium (Ir)

Materials

Compressibility Able to be squeezed or expanded, so that the mass fills less or more space.

...results in a change in density (mass / volume) of the object, because of the volume change.

Phases of Matter: Solid, liquid, gas (vapour)

Solids Not very fluid - Not very compressible.

– ***Liquids*** Very fluid - Not very compressible.

– ***Gases*** Very fluid - Very compressible.

Materials

Crystals form when molecules align in a lattice e.g.

- Cubic: Halite – Table Salt (NaCl),
- Pyrite (FeS_2)
- Octahedral: Diamond (C)
- Fluorite (CaF_2)
- Hexagonal: Quartz (SiO_2)
- Ice (H_2O)

You do not need to know these formulas!



Materials

Fluids

- Liquids **or Gases** – flow easily (i.e. change shape)

Viscosity

- How thick a fluid is
- Measure of resistance to flow
- Depends on temperature & chemical structure.

Viscosity

High viscosity – thick, slow flow

Low viscosity – runny, quick flow

Density

Density = mass / volume = ρ
(how much Matter is in a Space)

Units: kg / m³

Some Examples:

iron = 7870 kg / m³

ocean water = 1025 kg / m³

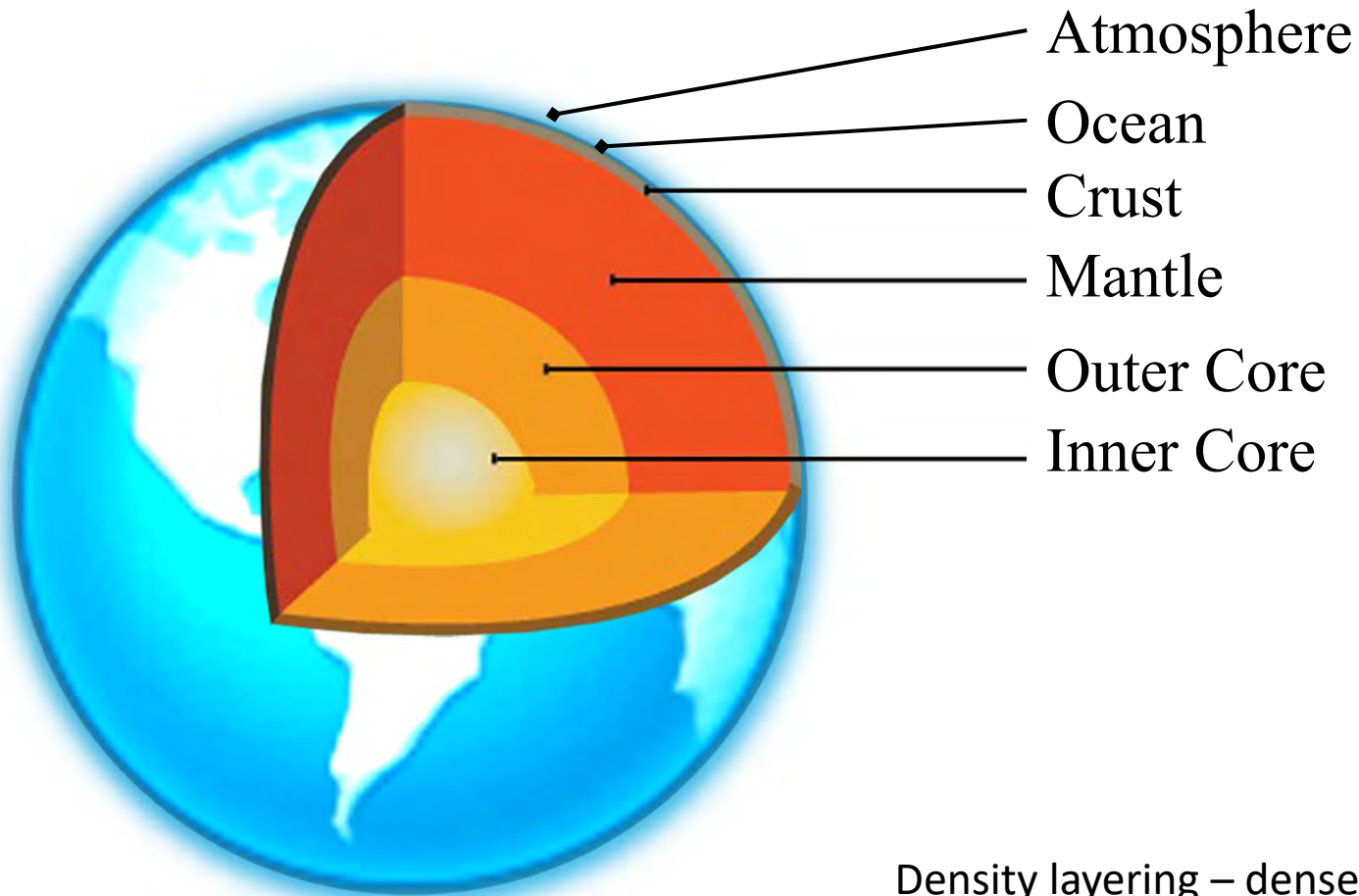
air = 1.2 kg / m³

Stratification

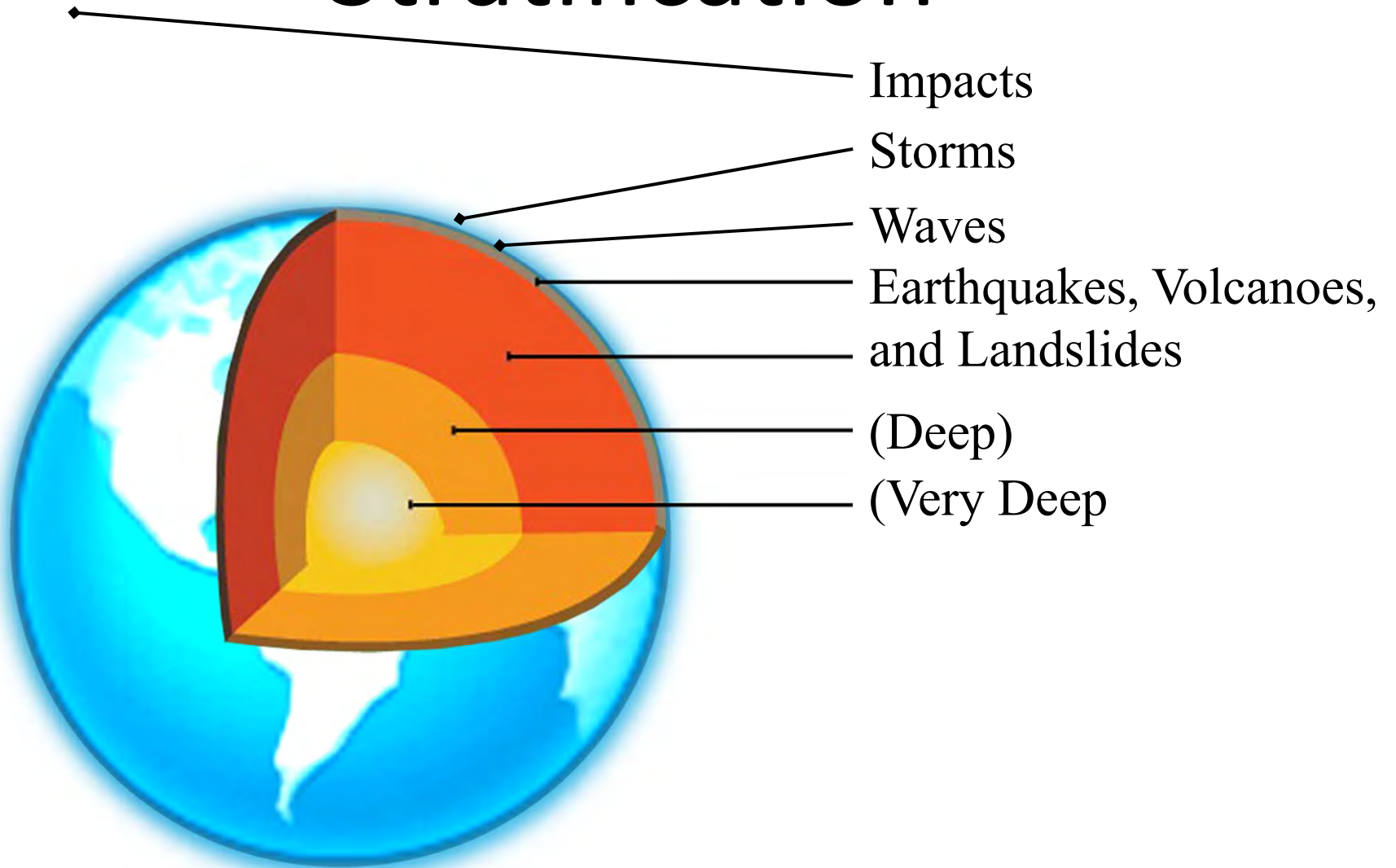
Less-dense materials float on top of denser materials.

Creates layers or Stratification

Stratification



Stratification



Stratification of the Earth System

These layers/strata are important for our disasters

Each of them occurs in one or more strata

The strata defines the disaster

Disaster Scales

Key to communicating disaster information

Use common, standardized terms and measurements

Bad example:

“The storm happened that-a-way, 2 generations ago, and was as strong as 500 screaming bunny rabbits.”

Reminder of Basic Units

International System of Units (SI)

Standard for time is: second (s)

SI Standard unit of distance is:
metre (m)

SI Standard unit of Mass (Matter):
gram (g)

Quantifying Disasters

Metric Prefixes:

k = kilo = thousand = 1×10^3

M = mega = million = 1×10^6

G = giga = billion = 1×10^9

T = tera = trillion = 1×10^{12}

c = centi = hundredth = 1×10^{-2}

m = milli = thousandth = 1×10^{-3}

μ = micro = millionth = 1×10^{-6}

n = nano = billionth = 1×10^{-9}

P = pico = trillionth = 1×10^{-12}

Quantifying Disasters

Numbers in metric

Value = number & magnitude & prefix & units.

Examples:

$$5 \times 10^2 \text{ km}$$

Means:

5 times 100 times thousand x m = 500,000 m

$$5 \times 10^{-1} \text{ Mm}$$

Means:

5 times 0.1 times million x m = 500,000 m (same thing!)