2016

GEL105: IGNEOUS PETROLOGY

Disney Pixar: LAVA

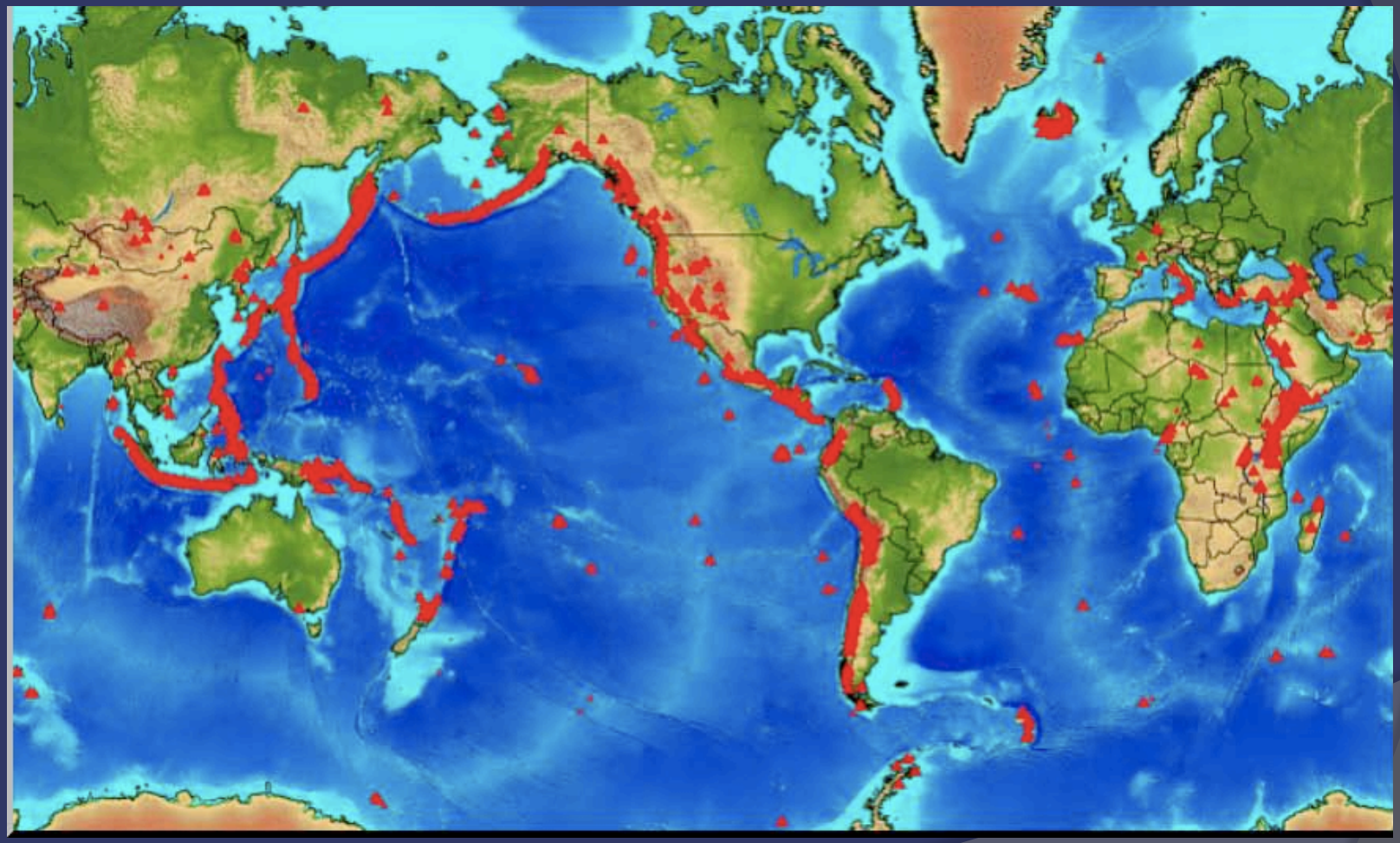
- Instructor: Sarah Lambart
  - Office hour: Thursday from 12 to 1pm + by appointments in my office (room 1205A)
- TA: Kevin Schrecengost and Allie Rubin
  - Office hour: in room 1362
  - Kevin: Tu/Th 10-11am; Allie: Tu/Th 9-10am
- Class website: Smartsite

  www.smartsite.edu
- Textbook: Winter (Principle of Igneous and Metamophic petrology)

- Labs:
  - Twice a week for 3 hours each session
  - 7 labs largely based on California rocks
  - Term project (will be introduced in two weeks)
- Grading: 4 units - ~60% lecture/40% labs
  - 2 midterms
  - Final exam
  - 5 problem sets (on lecture material)
  - Lab/lab quizzes
  - Term project
  - Figure presentation
- Late work: - 25% per late day (for PS only!)

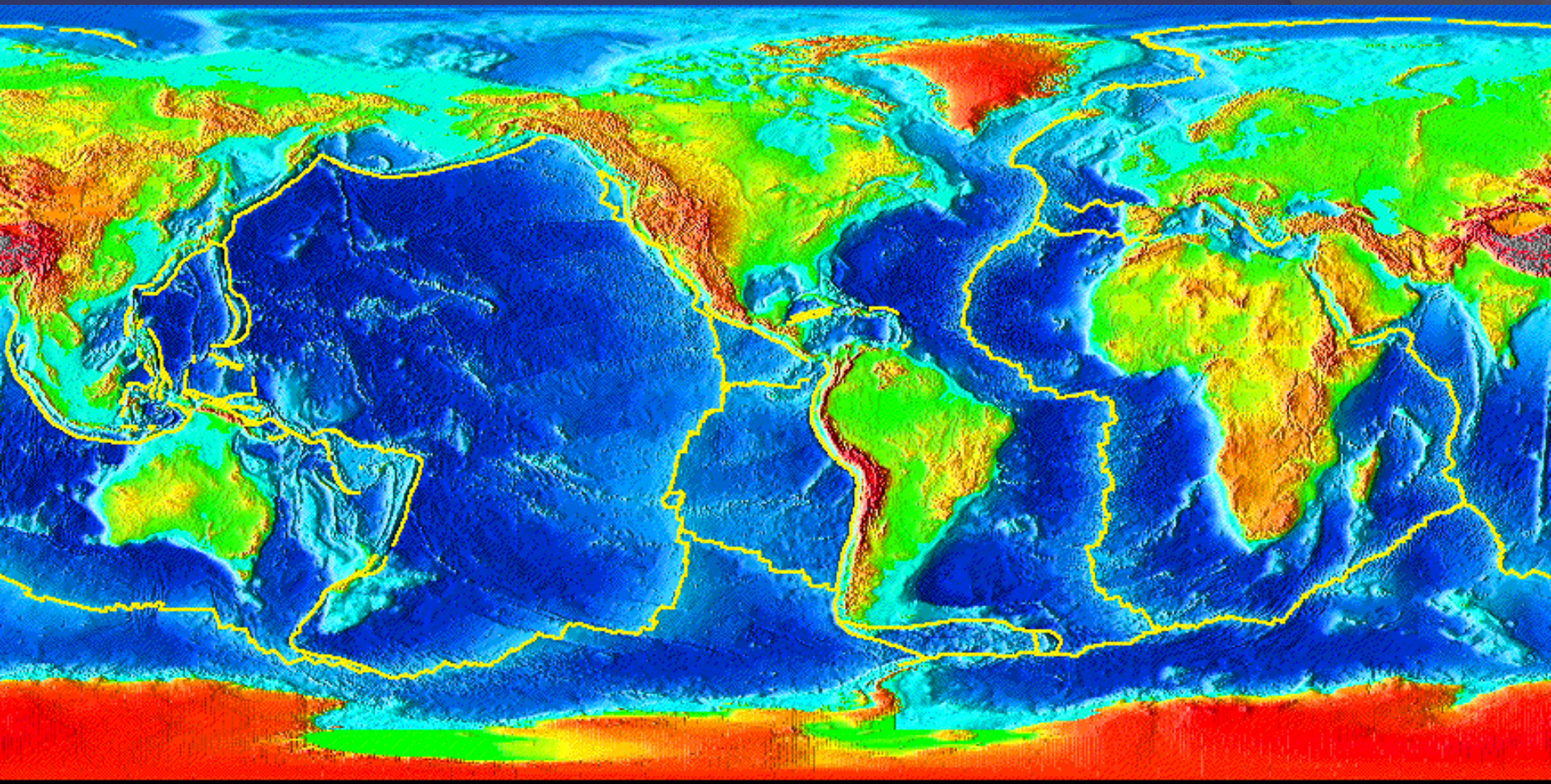
What is Igneous Petrology?

Plate tectonic vs. Volcanism

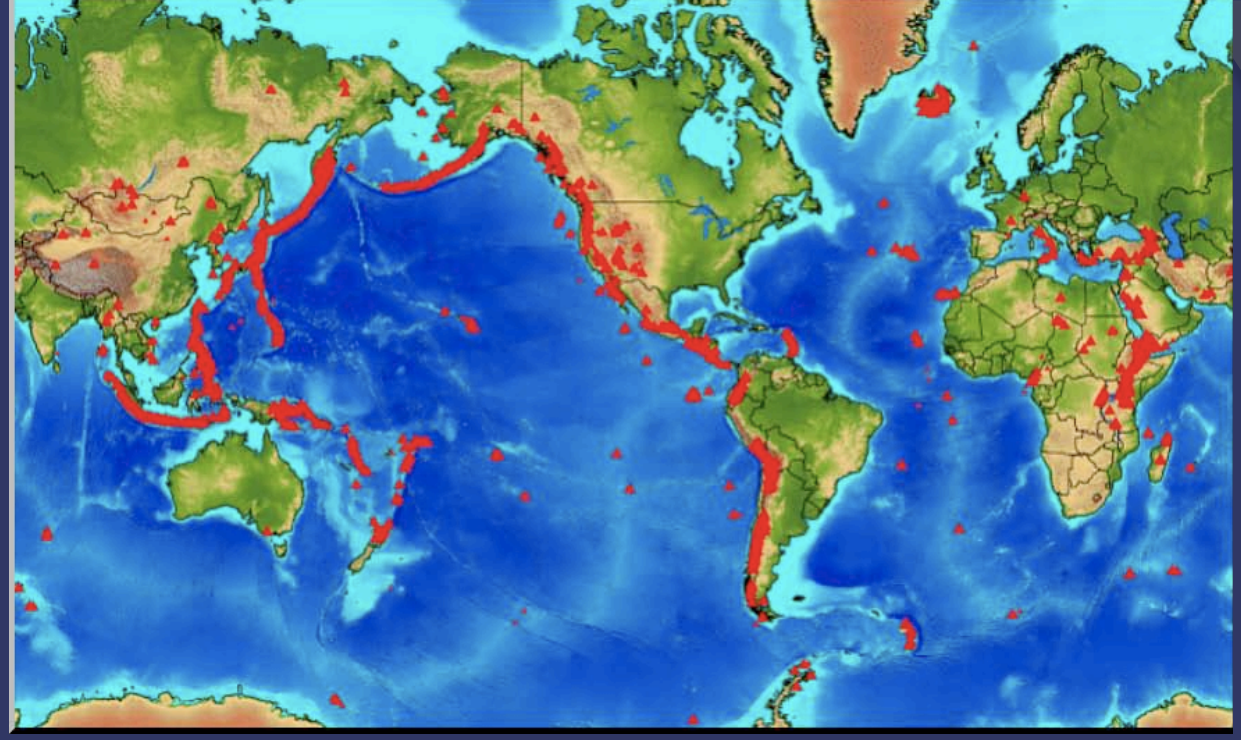


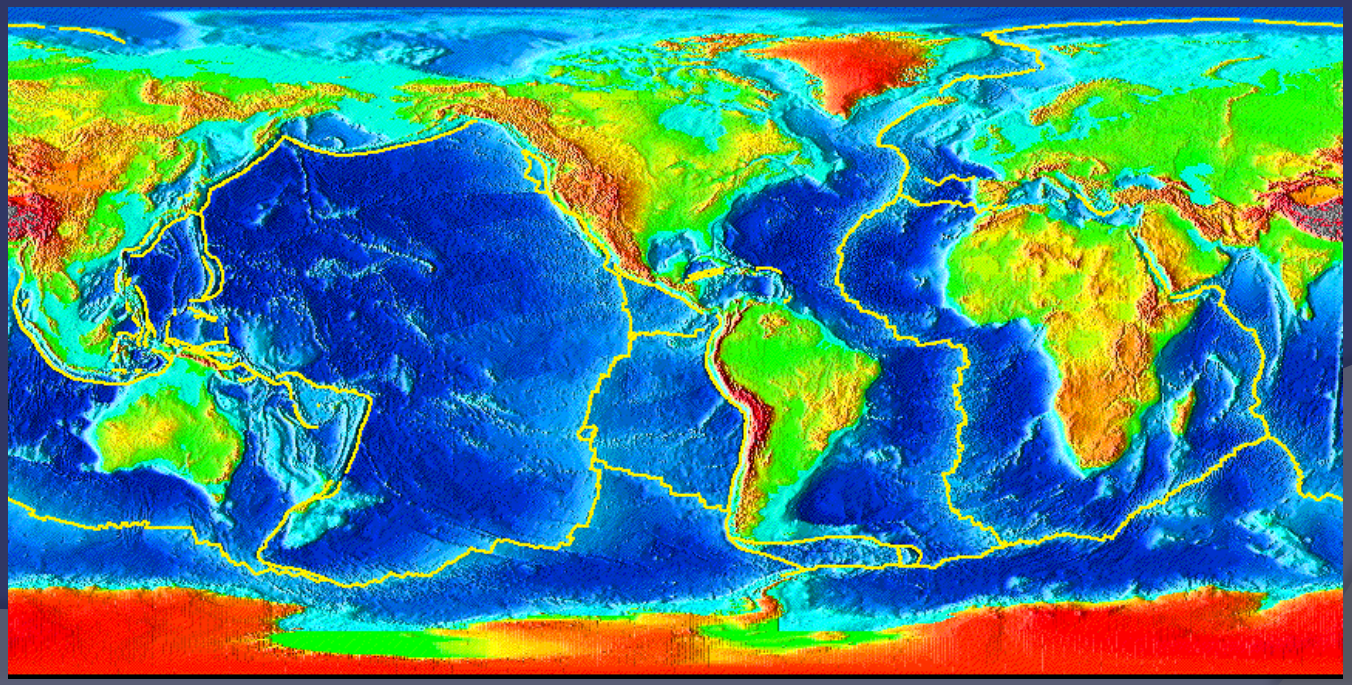
Note: this does not include mid-ocean ridge volcanism

Smithsonian Global Volcanism project - http://www.volcano.si.edu/world/find_regions.cfm



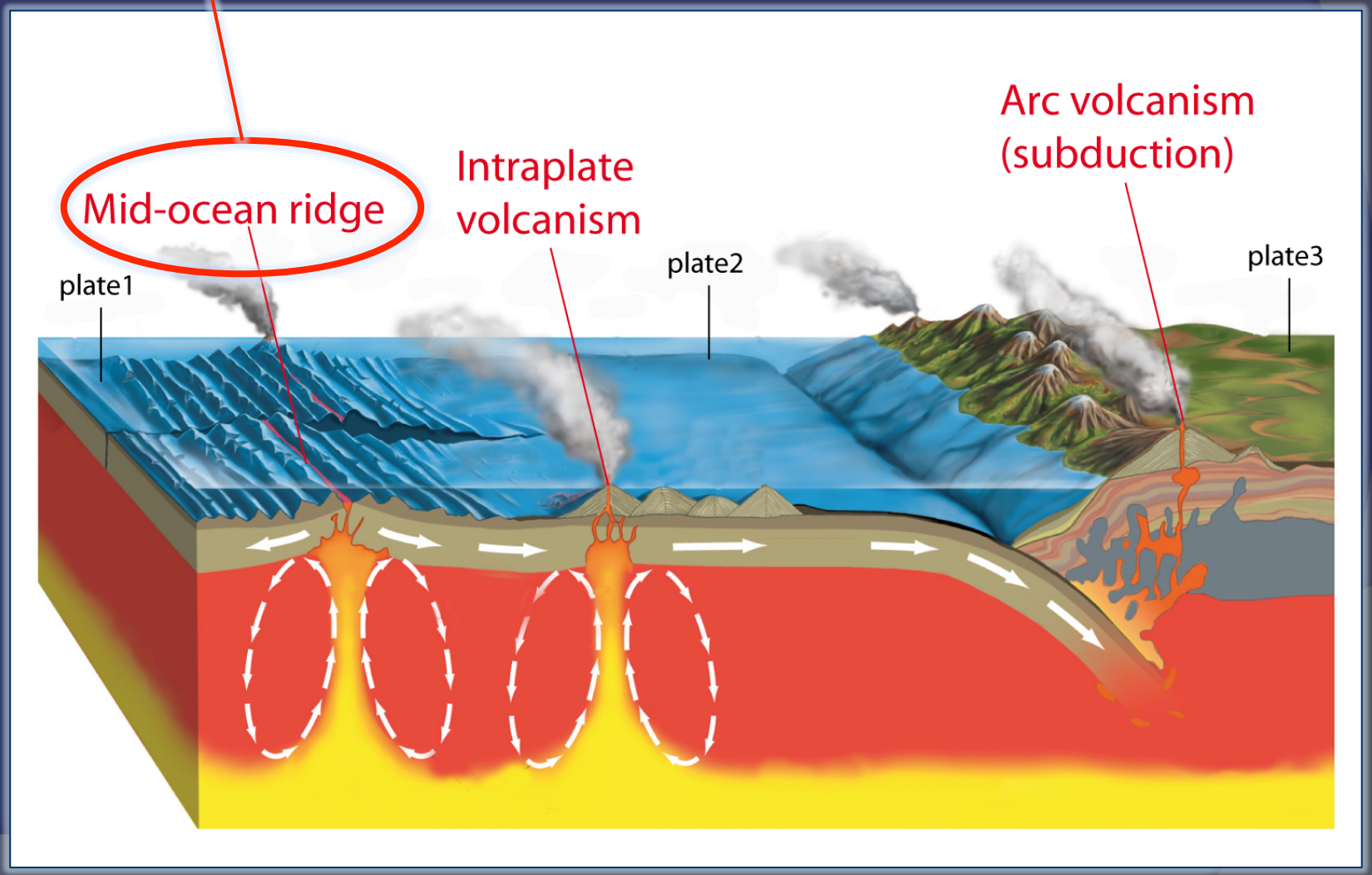
Crustal Plate Boundaries





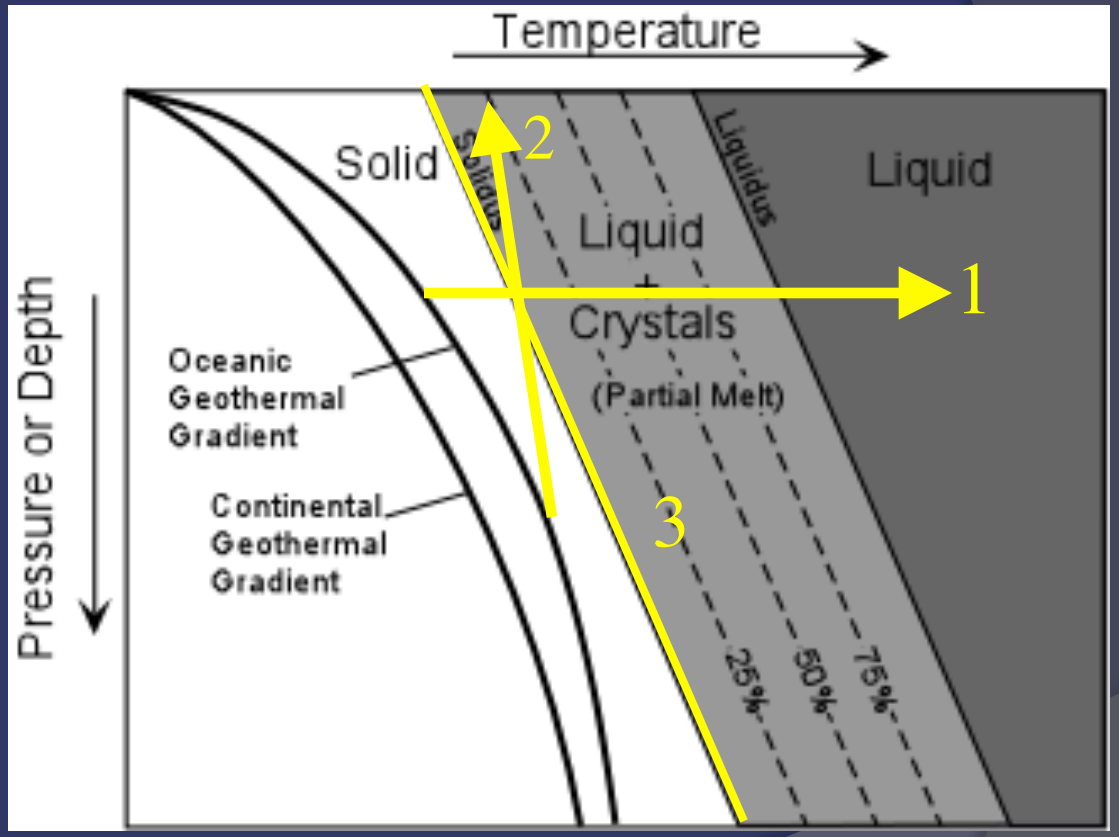
Active magmatism: 0.6% Earth's surface

85% of the Earth's magmatic production / 70% Earth's surface



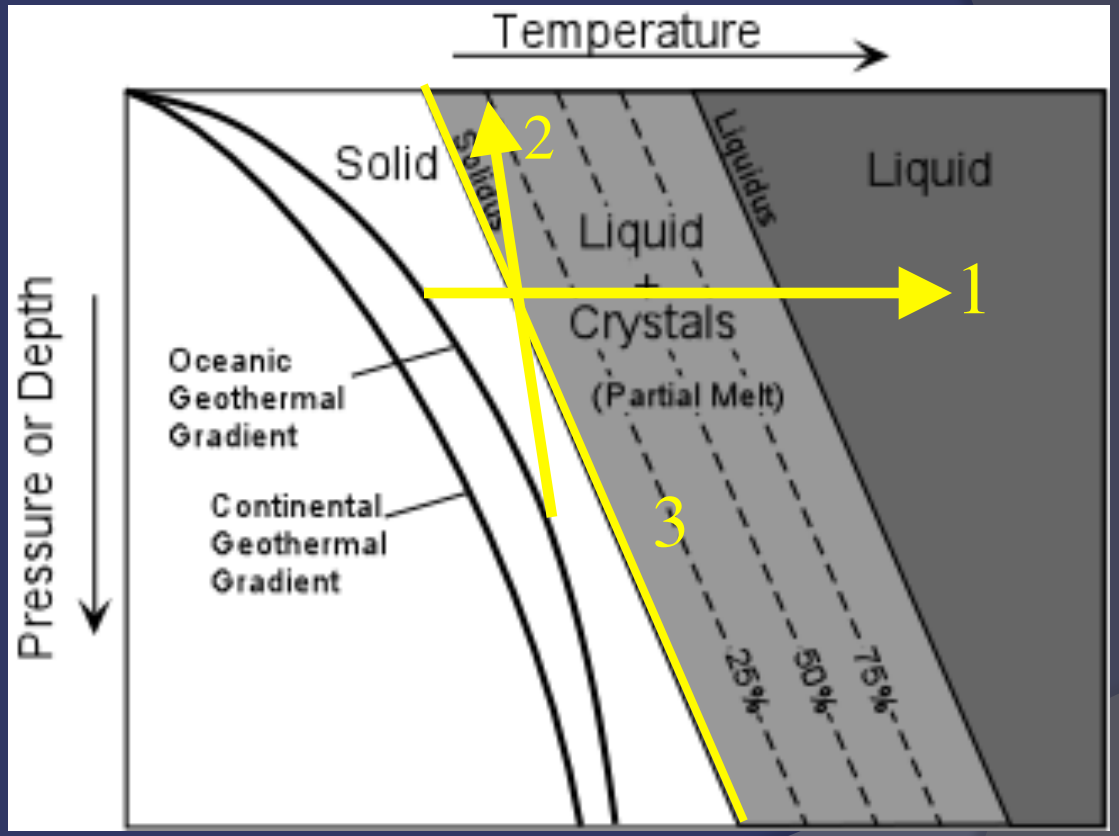
How do you melt rocks?

1. Heat them (e.g., ice at room temperature)
2. Decompress them (lower pressure)
3. Change the composition (e.g., add salt to ice / water to rock)



How do you create igneous rocks?

1. Heat them (e.g., ice at room temperature)
2. Decompress them (lower pressure)
3. Change the composition (e.g., add salt to ice / water to rock)



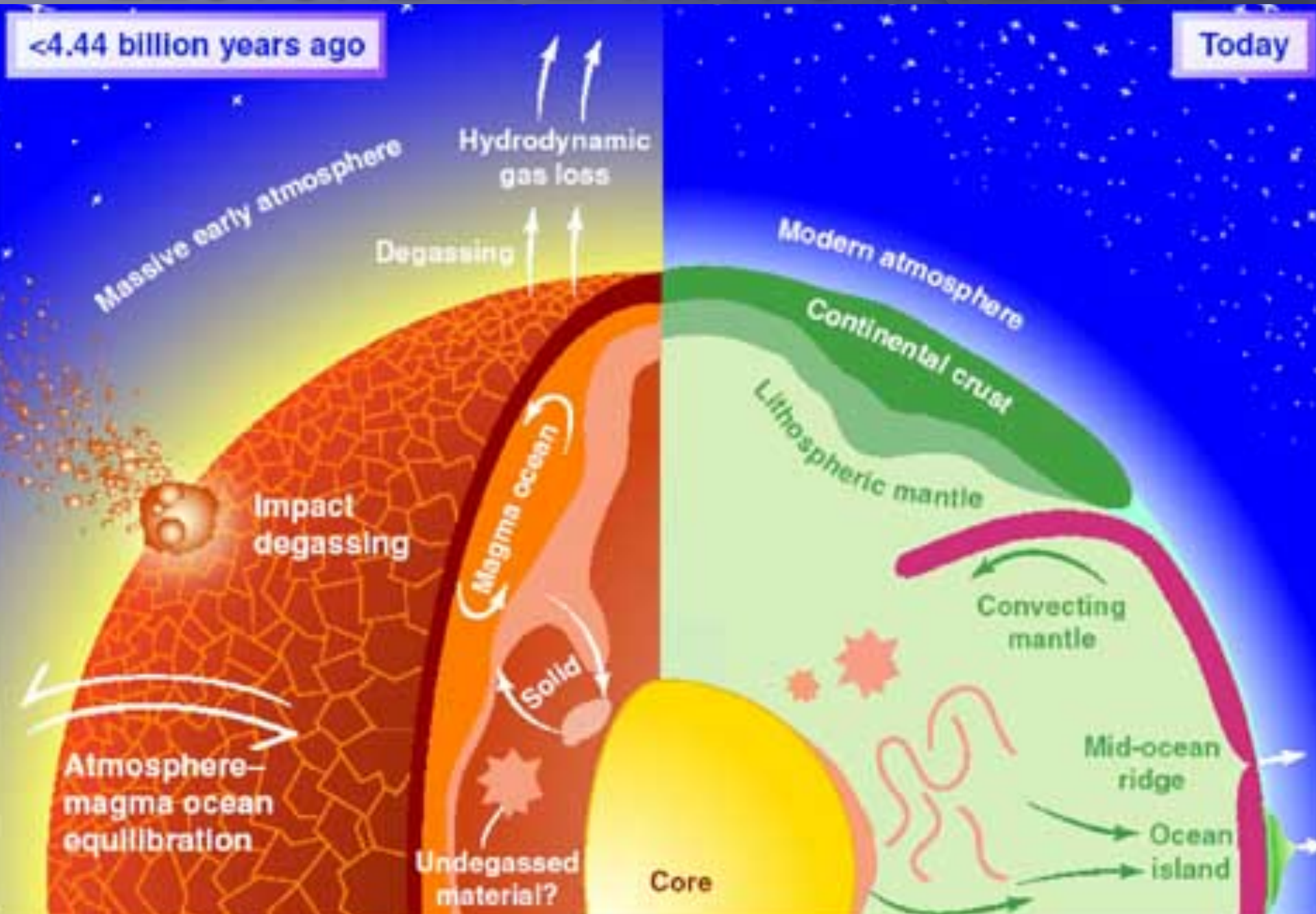
Temperature decrease ⇒ crystallization

Goals of this class:

- Learn how to use the textural and chemical information of rocks to understand origin and process

- Relate this to the bigger picture

LECTURE 1: EARTH'S INTERIOR



Earth's interior:

Chemical Mechanical

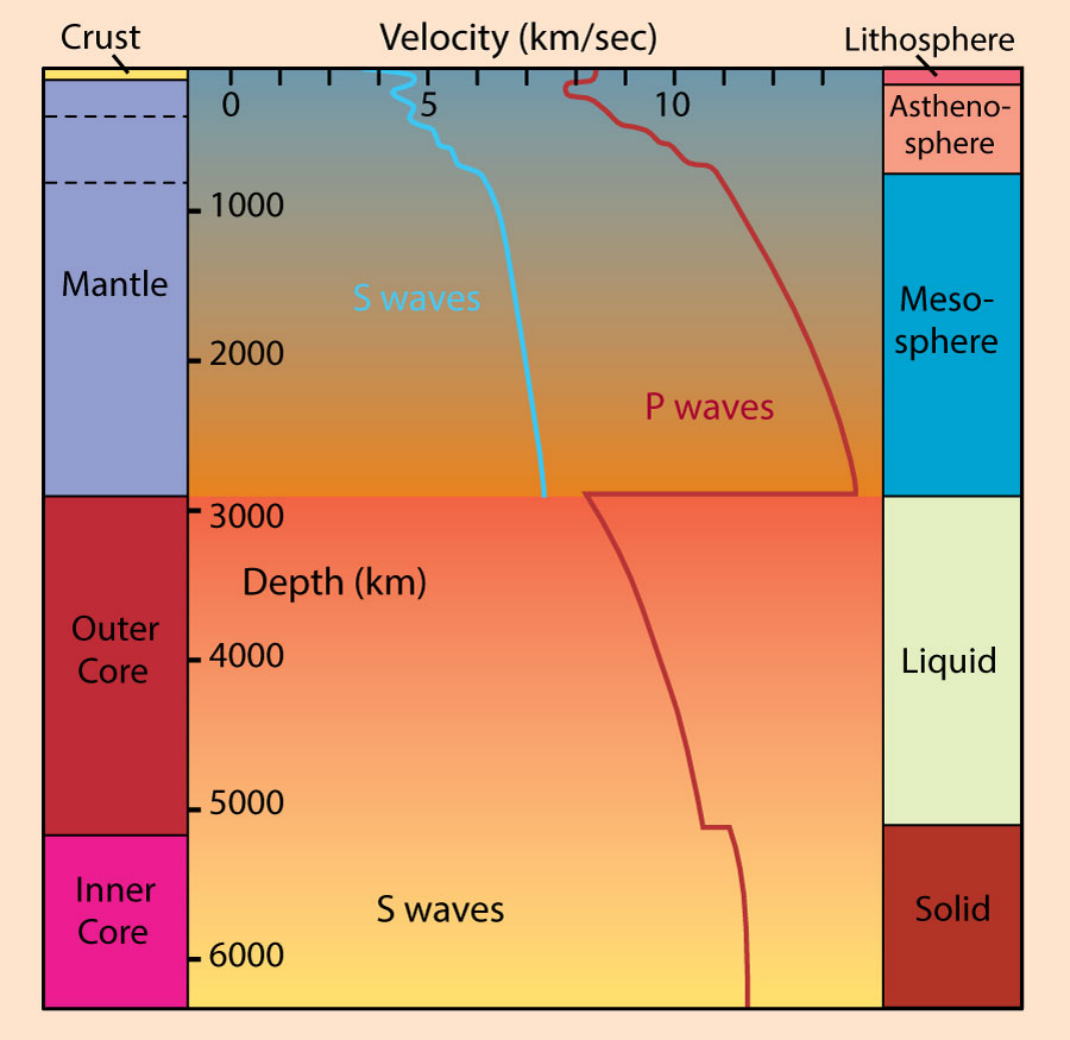


Figure 1.3 in Winter

Compositional layers

δ = 2.7 (granite) to 2.9 (basalt)

δ = 3.3 to 5.5 (olivine)

δ = 10.7 (Fe, Ni ± S)

δ(Earth) = 5.5

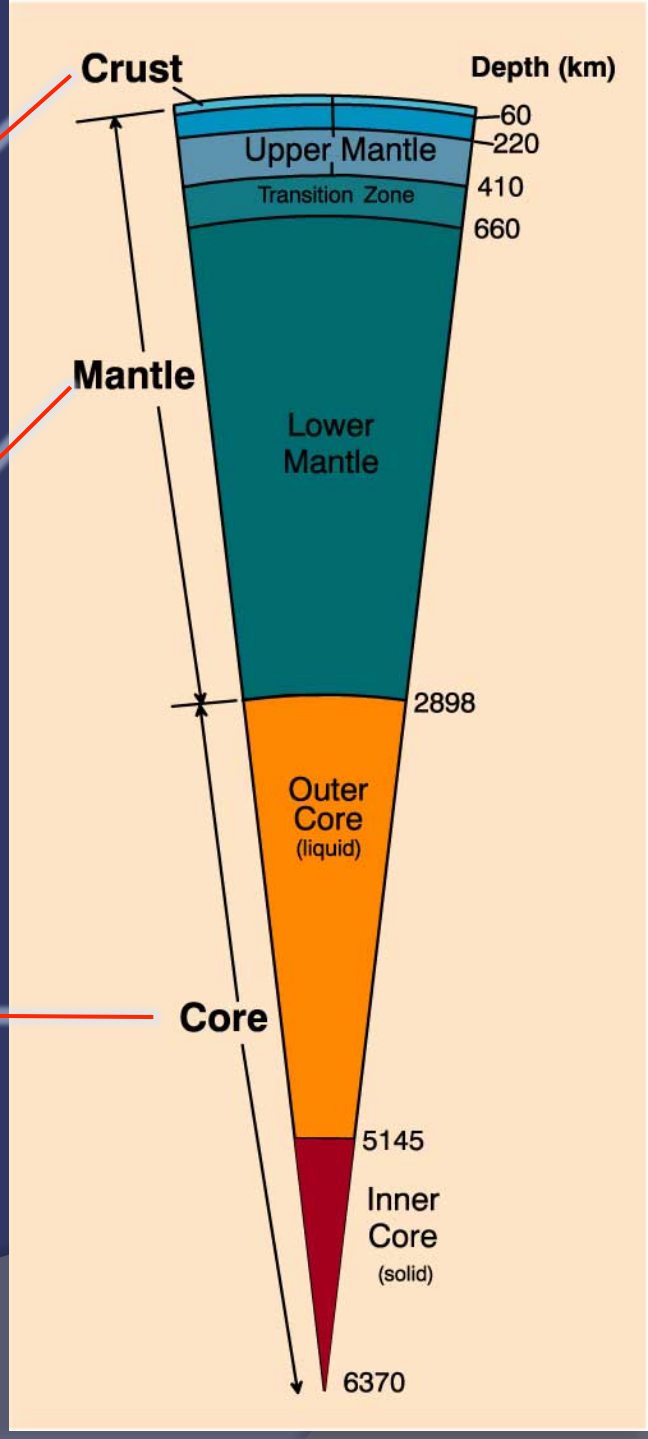
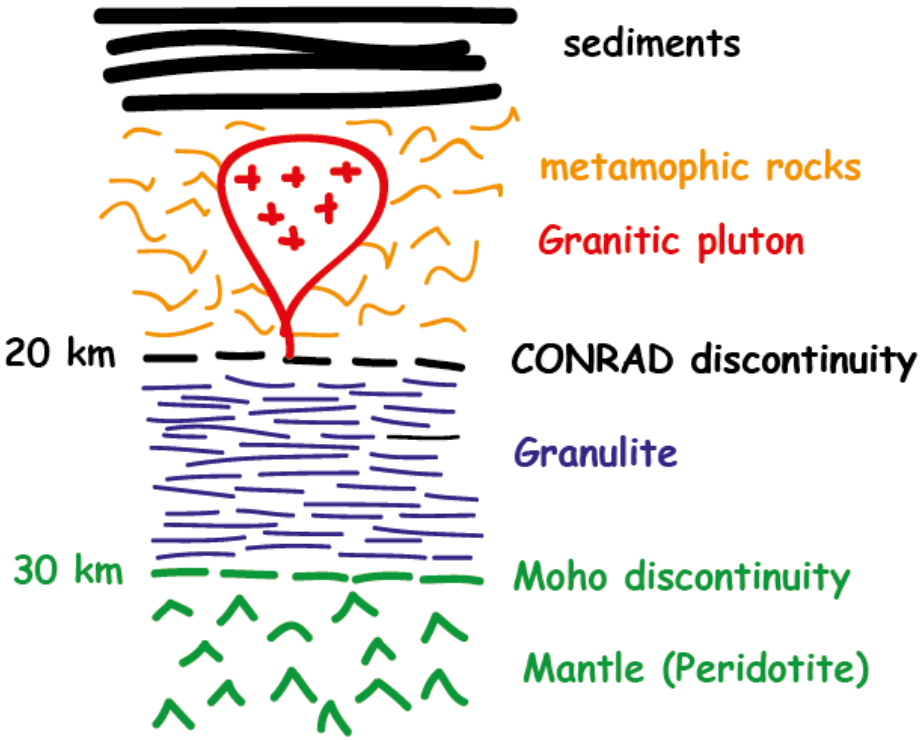


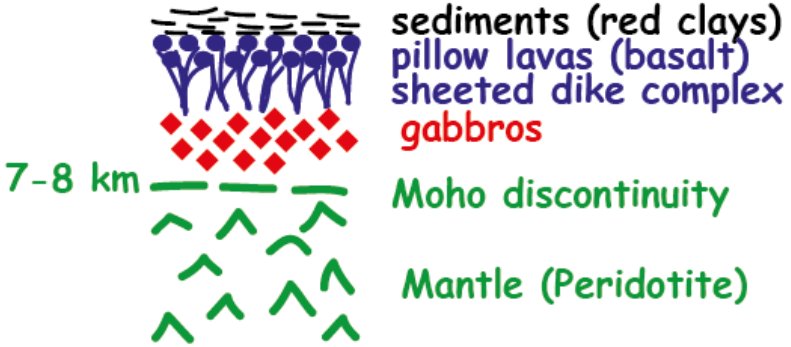
Figure 1.2 in Winter

Crust

Continental crust



Oceanic crust



Mechanical layers

Geothermal gradient: non linear with depth

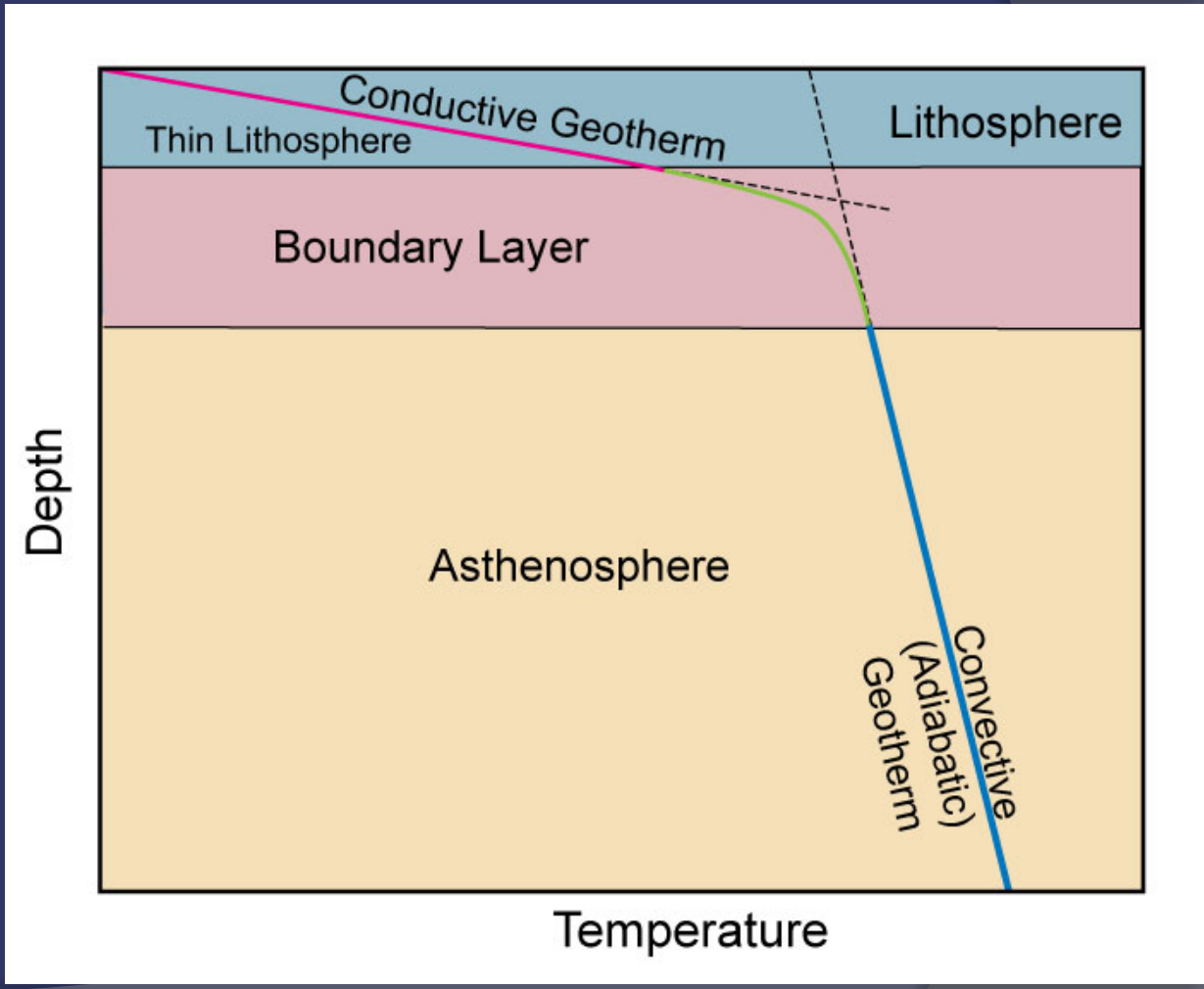
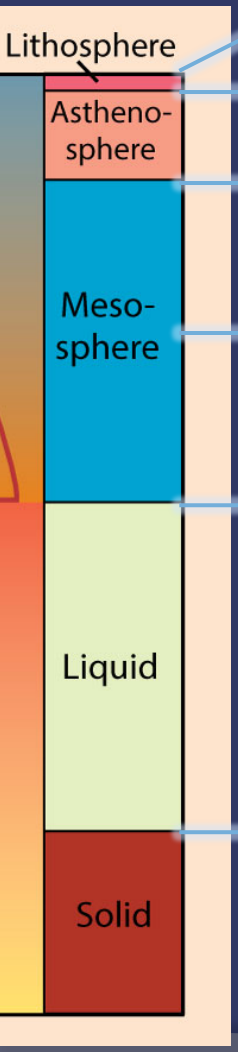


Figure 1.9 in Winter

Mechanical layers



= crust + part of the mantle

Elastic Solid

1300°C (100-150km)

200 km

660 km: no more seisms

Ductile Solid (or viscous fluid)

3000-3500°C (2900 km)

Liquid

5000°C (5200 km)

Ductile Solid

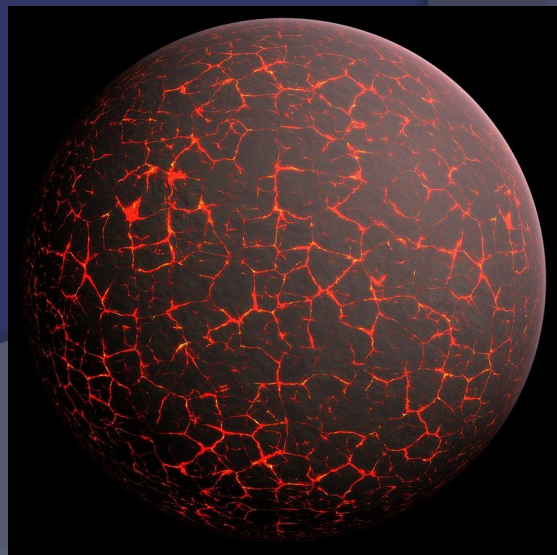
LET'S BUILD A PLANET…

Earth's origin

- How did Earth form?
- How did we get the layered planet we have today?
- What is the bulk composition of Earth?
- When did all of this happen (and how long did it take)?

Few dates

- Universe origin: Big bang – 12 to 15 Ga
- Milky way: 10 Ga
- Solar system: 4.56 Ga (from solar nebula): 99.9% of the mass collapses to form the Sun
- 4.54 Ga: Earth's formation

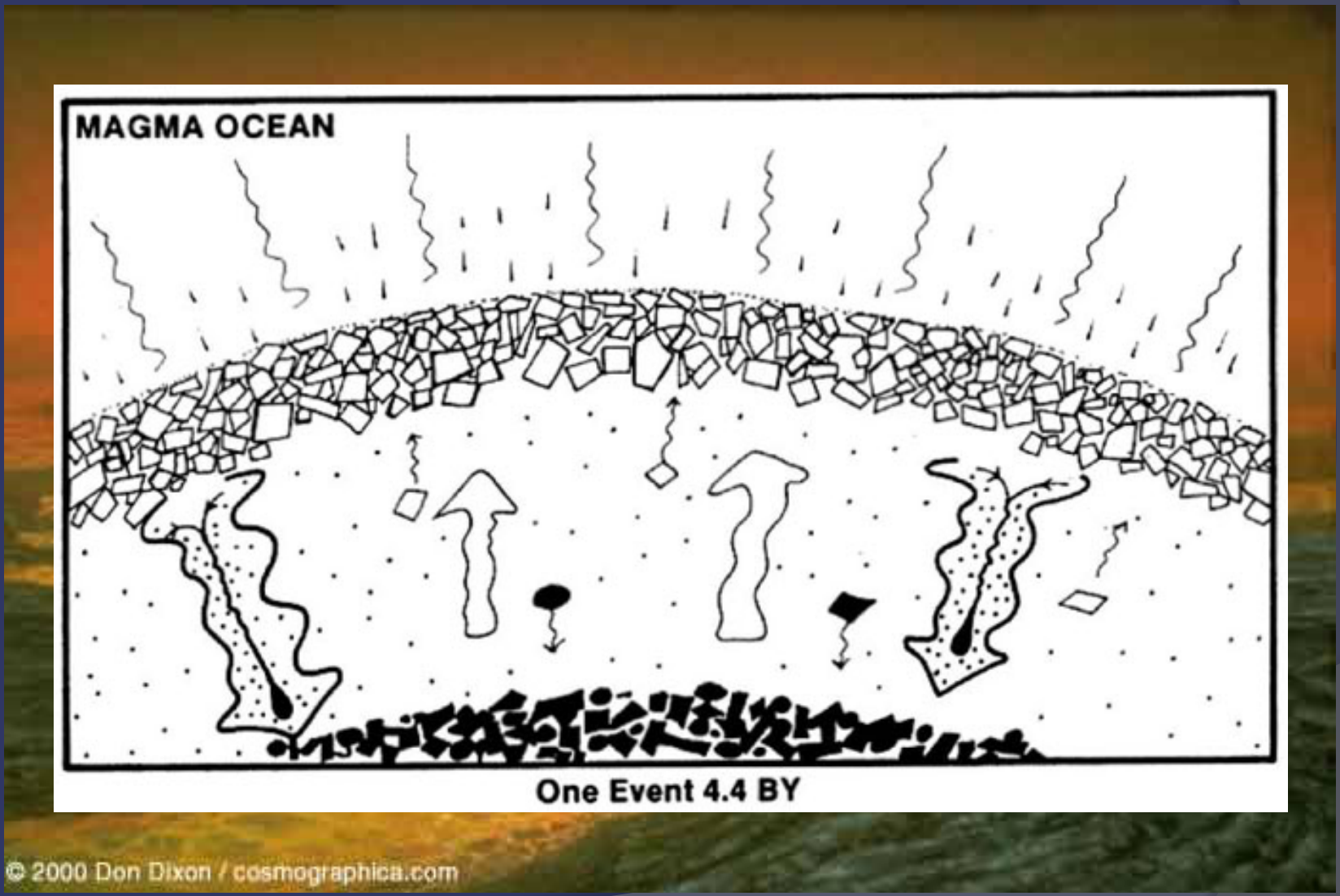


Few dates

- Mars-size impactor: Moon formation

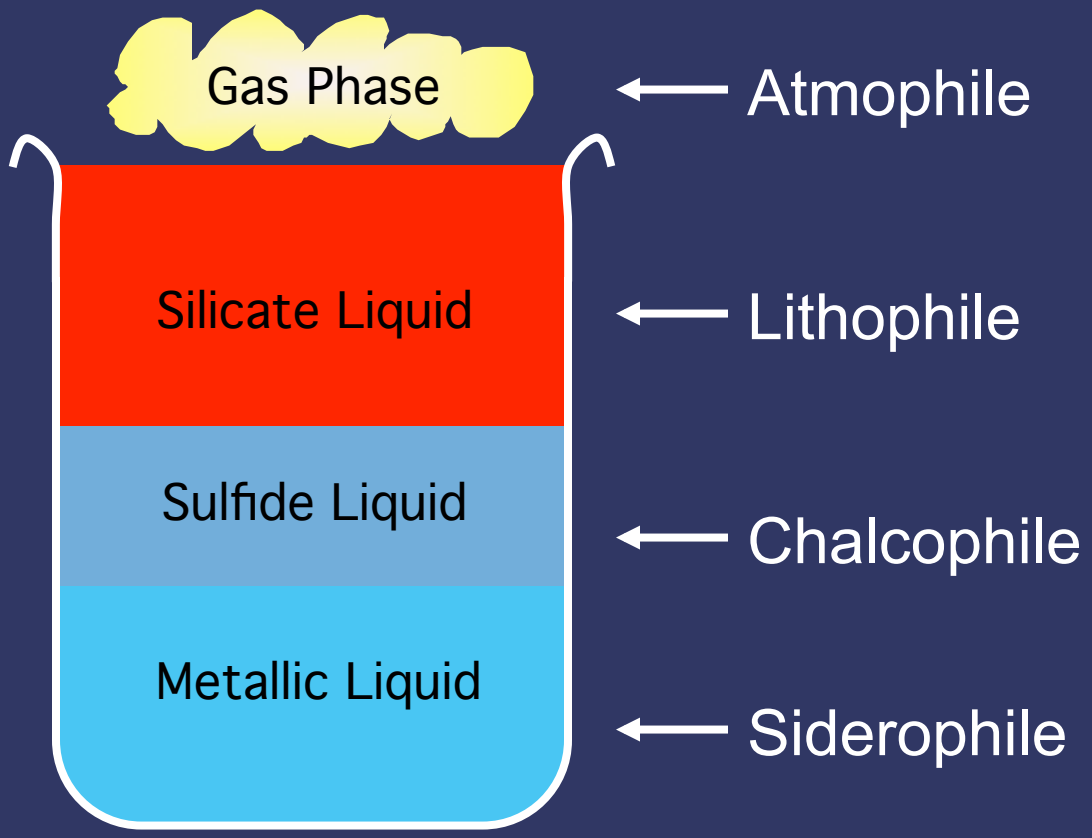
Magma ocean

Magma ocean: 1st magma chamber



Why a layered Earth?

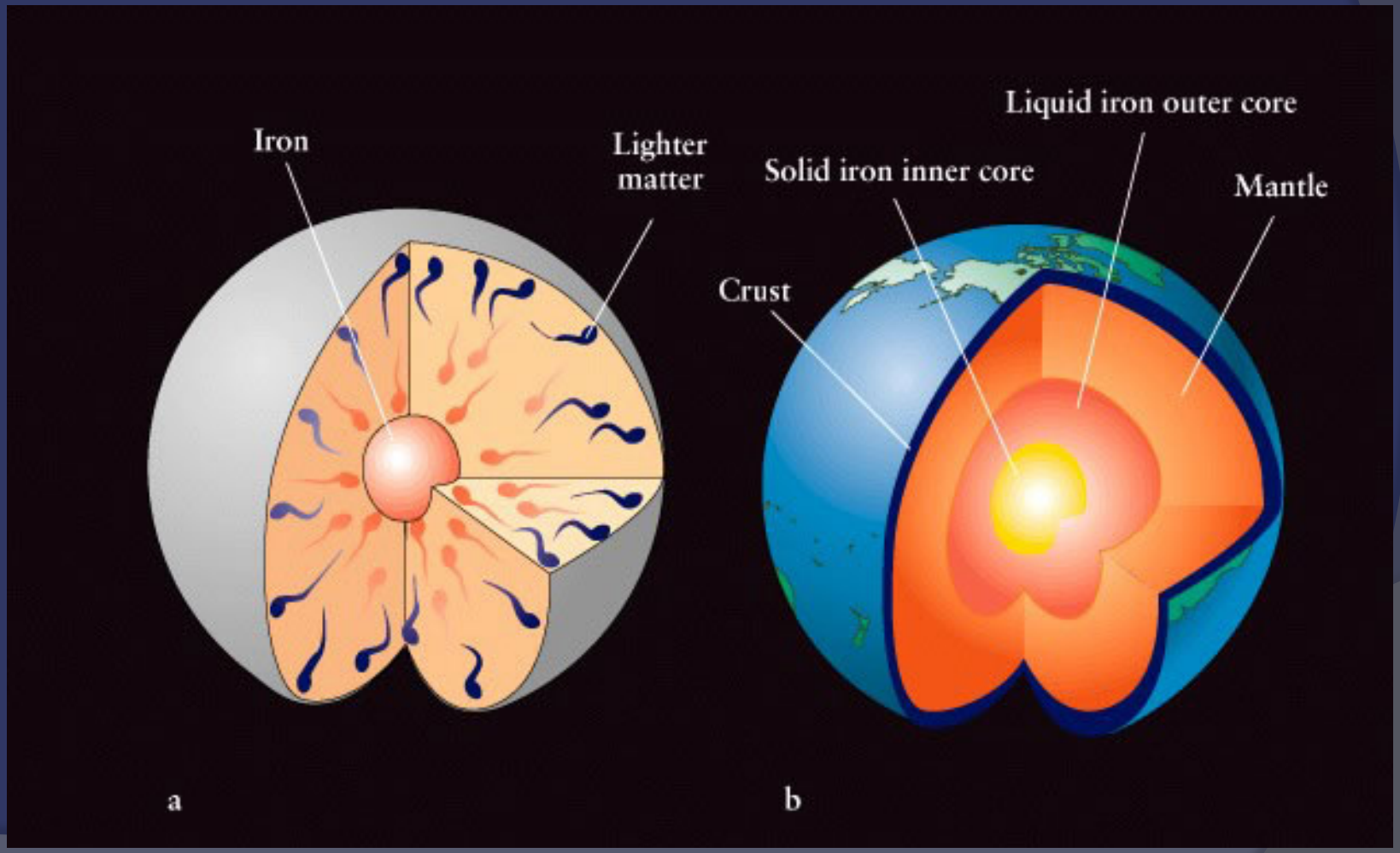
- Goldschmidt classification (1937)



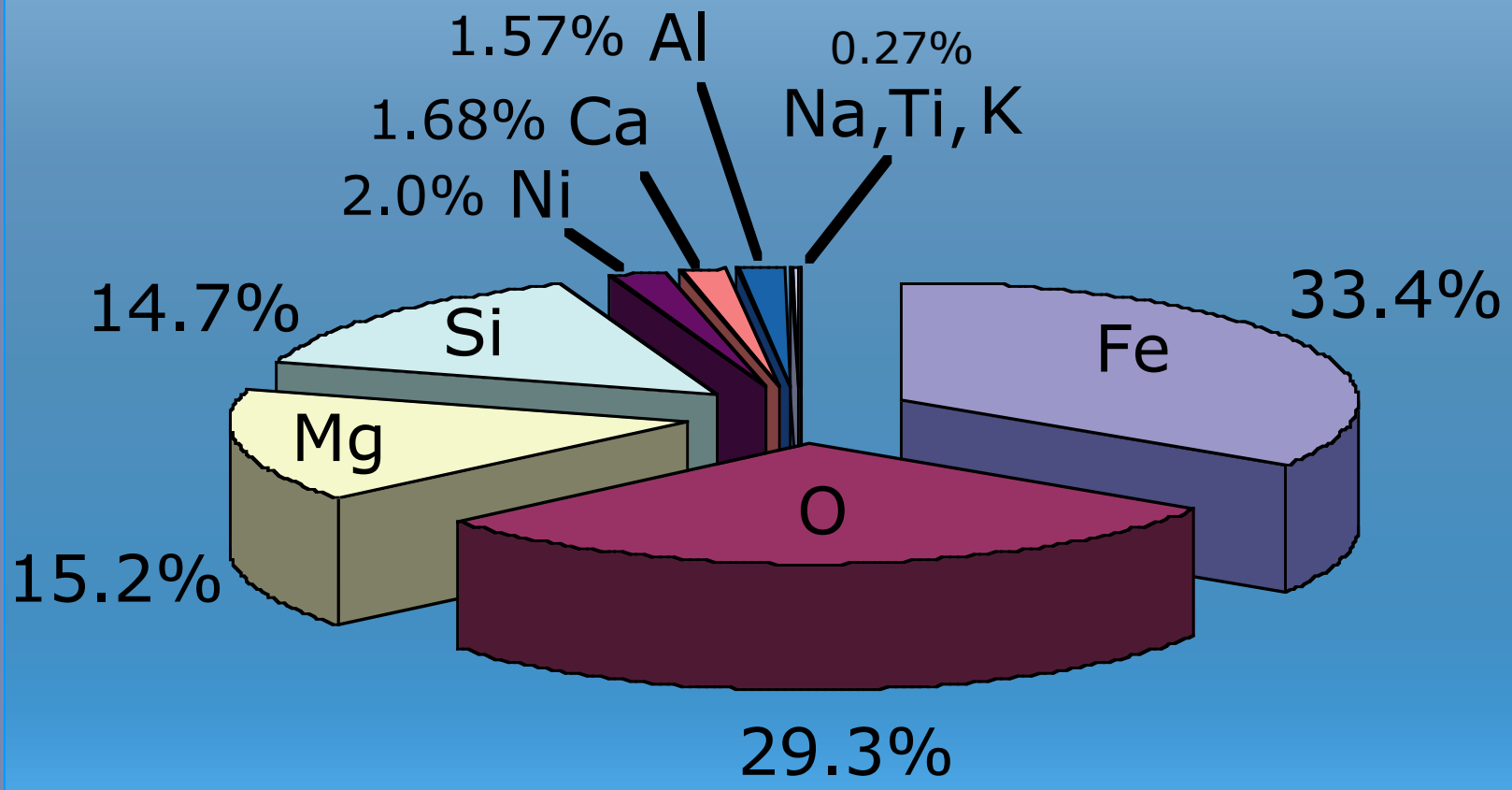
To first order, distribution between core and mantle: equilibrium partitioning between metal liquid and silicates (but no separate sulfide phase)

Why a layered Earth?

- Simple model



Bulk Composition of the Earth (in wt.%)

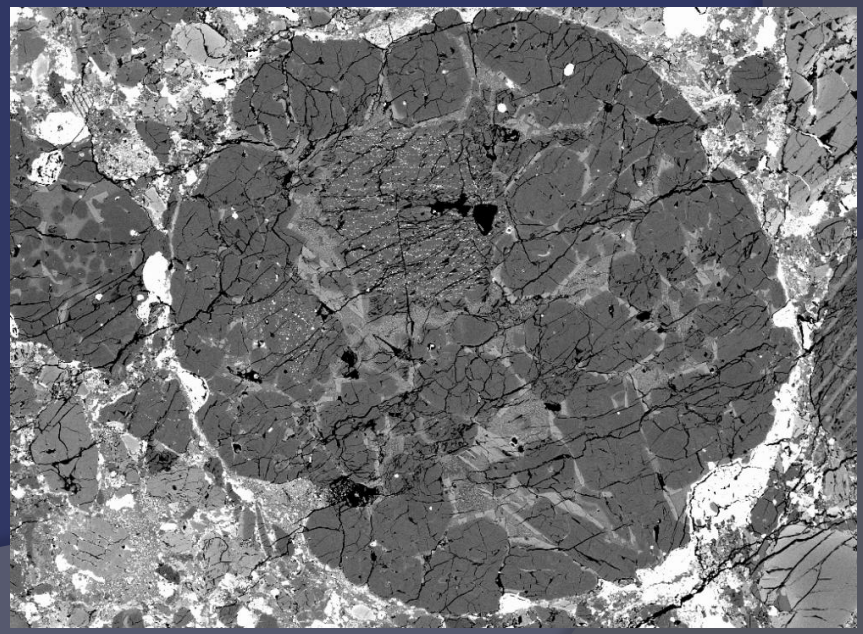


Fe, Mg, Si and O: account for 93% of the mass of Earth

How do we know all this?

Fig. 9. Meteorite collecting in Antarctica, during the 1978-79 season. Here the specimen is a tiny fragment of carbonaceous chondrite. Kazuyuki Suraishi of the National Institute of Polar Research, Tokyo, photographs the meteorite before moving it; Ursula Marvin of the Harvard-Smithsonian Center for Astrophysics holds a scale and numbering device that will appear in the photograph for identification. This photograph is by W. A. Cassidy.

Carbonaceous Chondrites = Bulk Earth Composition



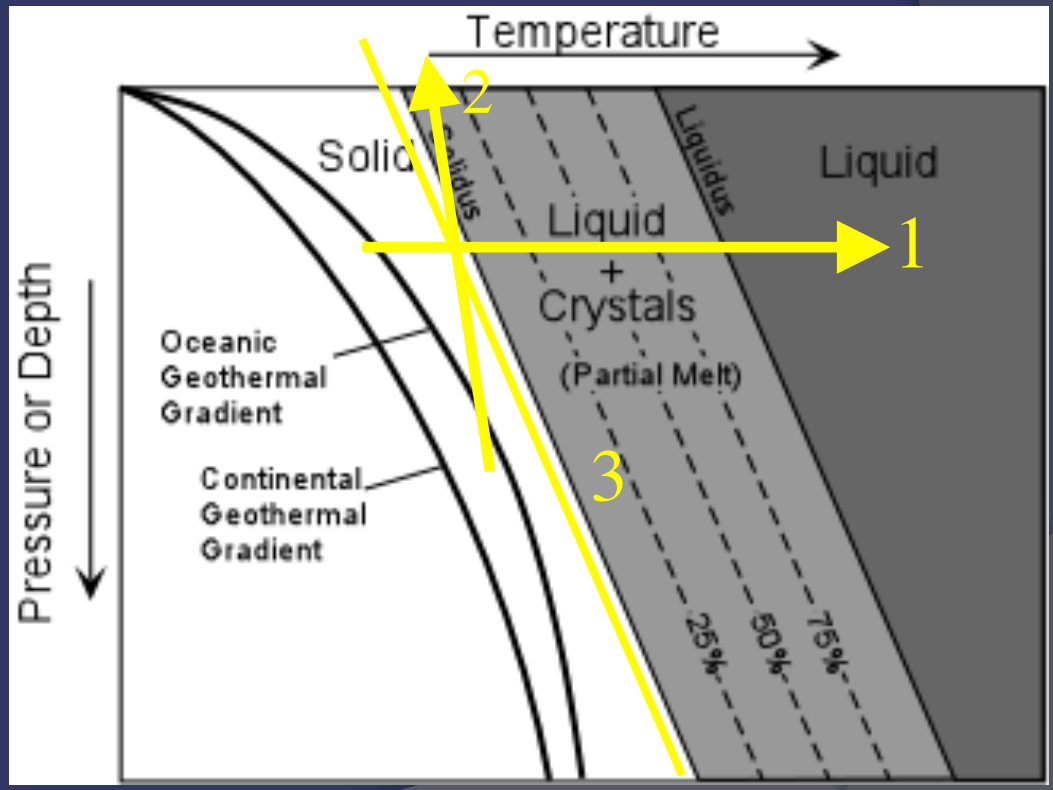
BSE image of a chondrule
Credit: Steven Simon

AND NOW?..

Sources of energy

- Remnant heat from Earth's accretion
- Radioactive decay

Works



NEXT TIME

1001 recipes to create an igneous rocks…

TO READ:

Chapter 1 (recap of lecture 1)

Chapter 2 (help for Lab 1)