LECTURE #2: Energy Sources for Disasters

Date: 13 January 2025

I. Review from last class

- syllabus/website details
 - o website: http://ivis.eps.pitt.edu/courses/geol0820/
 - contains all information about the class, course notes, etc.
 - notes typically go online the morning of that day's lecture
- *introduction to the topic of natural disasters*
 - \circ be sure to review the notes if you missed the first class

II. This week

- the link to the first video homework is active
 - please make time to watch and take notes

• Recitations start this week (tomorrow)

- please make sure you attend the class and talk with your TA about what is expected because *this is a large percentage of your grade!*
 - make sure that you have your copy of the recitation manual (*it is now in the Pitt Bookstore (https://pitt.verbacompare.com/comparison?id=4701496*)
 - you will need this for the first recitation in order to complete the work

III. Energy Sources for Disasters

- 1. external heat (Sun)
- 2. internal heat (Earth)
- 3. force of gravity

external heat

- o solar energy
 - drives atmospheric motions
 - hurricanes, tornadoes, etc.
 - > heat flow from the sun is 5300 times more than from the Earth's interior
 - very small fraction of solar output reaches the Earth's surface
 - of that, 25% goes into evaporation of water
 - drives atmospheric circulation
 - gives rise to large storms
 - wavelength related to the frequency (and the energy!)
 - $\succ \lambda = c / v$
 - > c = speed of light = $2.99 \times 10^8 \text{ m/s}$
 - > v = frequency (Hz or cycles/sec)

- what is solar flux?
 - amount of energy over a given area (W/m²)
 - measured perpendicular to incoming energy
 - there's a different flux at the equator than the poles
 - > different flux in Pittsburgh in the winter vs. the summer



• internal heat

- from the planet's formation
 - lower density materials like rocks, gases, water, radioactive minerals rose
 - higher density materials like metals sank
 - when the internal heat of the Earth > 1000°C (~ 1800°F) iron melted and the liquid sank toward the core (gravity)
 - released potential energy
 - > increased the temperature even more!
 - > enough to melt rocks and begin the process of differentiation of the Earth's layers (core, mantle, crust) → we will examine this more in the coming weeks
- o from impacts of comets and asteroids early in the Earth's history
 - tremendous amount of heat created and stored
 - \succ transfer of potential energy \rightarrow kinetic energy \rightarrow frictional heating

Potential Energy (PE) = m g h

Kinetic Energy (KE) = $\frac{1}{2}$ m v²

- > where,
- > m = mass of the object; g = gravitational constant
- > h = height/distance traveled; and v = velocity of the object
- so, how would you solve for the velocity of an object?
- > work out your solution here before lecture:
- o from continued decay of radioactive elements
 - this heat drives plate tectonic motions
 - > earthquakes, volcanoes, etc.

- o radioactive minerals
 - we will talk more about elements/chemistry in the next class
 - unstable and over time decay (radioactive decay)
 - examples:
 - > Potassium-40, Uranium-238, Thorium-232, many others ...
 - releasing neutrons, protons or particles from the atom's nucleus
 - > changing the atomic number/isotope and therefore the element
 - > the particle released is converted into energy
 - heat the surrounding rocks
 - damage/kill living tissue



Potassium-40 (19p + 21n) → Agron-40 (18p + 22n)

- half-life:
 - time required for ½ the number of atoms of the parent element to decay into the daughter element

Parent	Daughter	Half Life
Aluminum-26	Magnesium-26	720,000
Uranium-235	Lead-207	0.71 billion
Potassium-40	Argon-40	1.3 billion
Uranium-238	Lead-206	4.5 billion
Thorium-232	Lead-208	14 billion
Rubidium-87	Strontium-87	47 billion
Samarium-147	Neodymium-147	106 billion
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- age of the Earth
 4.57 billion years
 measuring radioactive elements in lunar rocks
 how can moon rocks tell us the age of the Earth??