EARTH121

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ESL: Earth science literacy
ESLP: Earth science literacy principles Key concepts to know for layman

1. Introduction

1.1. **James Hutton.** theory of the earth (1788)
geologic change is slow large changes require large amount of time

1.2. **principle of uniformitarianism.** processes that shaped earth throughout geologic time are the same as those observable today

1.3. **Sir William Logan.**

(1) map coal in ontario

gsc, mapping, natural resources

1.4. **J̇Tuzo Wilson.** geophysics, transform faults

1.5. **What is geology?**

(1) study of earth
(2) Earth in greek
(3) **Physical** material composition of earth
(4) **historical** development of earth through time(both slow and fast)
(5) earth always changing at all levels
(6) outcrops: bedrock on surface easy for geologists to study
(7) earth is has many hazardsj
(8) formation and occurence of vital resources
(9) maintaining supply and environmental impact of their extraction and use

1.6. **Catastrophism.** earth's landscapes had been shapen by catastrophes. Attempted to explain shape of earth in fixed time interval that it was a few thousand years old. 4004BCE

1.7. **Uniformitarianism.** physical, chemical, and biological laws that operate today always have been at work
wearthering shrunk moutains
the present is key to the past

1.8. **The Earth system.**

(1) lithosphere: rock surface and interior
(2) atmosphere: gaseous envelope,weather and climate
(3) hydrosphere: water, liquid, frozen
(4) biosphere: living matter

earth powered by sun and heat from internal radioactive decay

1.9. **Rock Cycle.** How matter is recycled

several different layers with varying physical attributes and chemical compositions

1.11. **Geologic time.** after radioactivity discovered, can accurately date stuff

1.11.1. *Relative Dating.* events placed in proper sequence by law of superposition
law of superposition: older stuff on lower layers of sedimentary rock. younger on top
principle of fossil sucession: fossil organisms success each other in definite order. time span can be determined by fossil content. could determine rocks of similar age based on types of fossils

1.11.2. *Magnitude.* earth 4.6 billion years old so time scale is extermely large
humans a speck in time, long period without life on earth or simple organisms

1.12. **Early evolution of earth.** earth product of remnant from big band
everything H and He
nebular theory:bodies evolved from rotating cloud called solar nebula, gas
eventually collapsed and period of contraction where things combine including elements
lots of impact on early earth meaning hot, heavy metal sank to bottom
melting formed buoyant masses for early crust
iron core, primitive crust, mantle

1.13. **Plate Tectonics.** continents fit
continental drift: continents moved across face of planet
paradigm evolved over long period of time

1.13.1. *continental drift.* wegener ignored first to propose idea
PAngea 200 mill yrs ago
just being able to fit continents wasnt enought evidence
continental shelf:gently sloping shelf platform of continental material extending from shore. fit better with this
streams deposit sediment enlarging shelves
found fossils on diff continents where they would fit together, including antartica
needed land connection for certain species to travel, i.e. plants seeds dont travel far
similar mountain ranges on diff continents. continuation
paleoclimatic evidence:dramatic differnet climates, glacial rock in africa
tropical swanps in north

1.14. **Planet of Shifting plates.** lithospheres, brittle crust
plates move relative one another at slow pace
unequal convection causing movement, large movements of liquid rock

1.14.1. *Plate boundaries.* all major interactions along boundaries
divergent boundaries, spreading, mid ocean ridge, sea floor spreading
convergent coundaries,descent into mantle, leading edge bent downwared, called subduction
transform fault boundaries, no production or destruction, slide past one another

1.15. **Earth's internal structure'.**

1.15.1. *Layers defined by composition.*

(1) crust:divided into oceanic and continental. basalt in ocean, 7 km thick, continent 35-70k. continentla composed of diversity of granite, and basalt etc.
(2) mantle: 82% volume of earth.boundary b/w crust and mantle has chemical change. dominant rock periodite, at depth becomes more crystalline due to pressure
(3) core:iron-nickel, extemely dense

1.15.2. *Physical properties.* grad. increate in density + temp. but since high pressure, not totally liquire

(1) Lithosphere and Asthenosphere:crust and transition area, melting point
(2) Mesosphere or lower mantle:increased pressure counteracts effects of higher temp., capable of gradual flow
(3) Inner and outer core: outer core: liquid, convective flow of metallic iron forming mag field. Inner core:behaves like solid even though higher temp

1.16. **face of earth.** continents and ocean
Continental slope: boundary between continents and deep ocean basins

1.16.1. *Continents.* young linear mountain belts
shields on stable interiors, large granite crystalline rock, could be 4 bill years

1.16.2. *Ocean basins.* linear volcano chains, canyons, large plateaus, extermely thin and deep trenches.

1.17. **Earth as a system.** group of interacting system
system: group of interacting part forming a complex whole.

1.17.1. *Rock cycle.* recycling of rock.magma formed in earth interior then migrates to outer surface and solidifies to form igneous rocks. on surface undergo weathering and become sediment and moves with grabvity or other forces like water glacier etc. sediments undergo lithification into sedimentary rock when compressed. if buried deep inearth, will be subjected to great pressure and turn into metamorphic. Additional pressure or temp turn into magma and cycle continues.

2. Chapter 12

2.1. **Paleomagnetism.** observe historic magnetic field by looking at type of rock and alignemnt of poles, as rocks cool, magnetized in parallel to existing magnetic field

fossil magnetism, paleo magnetism

2.2. **polar wanderin.** look at magnetism of rocks, see that it gradually shifted from somewhere in pacific to the canadian arctic. caused by continental drift

ocean floor mapped and drilled and discovered it was new

2.3. **sea floor spreading.** propose ocean ridges above zones of upwelling and seafloor carried away from ridge crest. tensional forces fracture crust and allow magma to intrude to create new crust

deep ocean trenches where crust drawn back into earth, older portions consumed

2.4. **geomagnetic reversals.** normal polarity: same magnetism as present magnetic field

reversed polarity: opposite current

alternating stripes of high and low intensity magnetism parallel to ridge crest (using magnetometer), high intensity normal polarity, low intensity reversed.stripe increase in width as floor spreads

originaly though earth was epxaning but volume and diameter remainded constant

tuzo wilson proposed large faults connected global belts into continuous network that divides earth outer shell into plates. At ocean ridges, moving apart, trenches, moving together, transform faults moving parallel

2.5. **plate tectonics.** explain observed motion of lithosphere through subduction and sea floor spreading

lithosphere surrounds asthenosphere, lithosphere broken into plates (change in size and shape),

Major

(1) north american
(2) south american
(3) pacific african
(4) eurasian
(5) australian-indian
(6) antarctic

Minor

(1) carribean
(2) Nazca
(3) Phillippine
(4) Arabian
(5) cocos
(6) scotia

2.6. **Divergent plate boundaries.** located along crests of oceanic ridges.as plates move away from ridge axis, molten rock wells up to produce slivers of sea floor

magma in fractures form dykes that cool outward – inward

2.6.1. *Continental Rifts.* spreading centres developing within continent. How pangea separated. caused by opposing tectonic forces pulling lithosphere apart

2.7. **Convergent plate boundaries.** to accomodate newly formed lithosphere, older potions return to mantle on convergent boudnaries and consumed(destructive plate boundaries).

leading edge of one plate bends downward (subduction zone). forms ocean trench.

when continental plate reaches ocean plate, ocean plate sinks as it is denser and heavier while continental plate floats. Some of the content on the oceanic plate scraped off on continental plate(accretionary wedge)

when descending plate 100km head drives water and voltaile components from subducted sediment to overlying mantle. Acts as flux inducing partial melting of mantle rocks. magma formed less dense then rocks of mantle and rise buoyantly, pool beneath overlying continental crust, may give rise to volcanoes (Mount St helens)

two oceanic plates convering cause similar effect, volcanoes build upward forming arc shpaed chain of volacnic islands

continents converging create mountains cuz cant sink

2.8. **transform fault boundaries.** strike-slip faulting, plates move past one another, Tuzo wilson

most transform faults join two segments of mid ocean ridge part of prominent linear breaks called fracture zones

3. Chapter 2 – Minerals

3.1. **Minerals.**

(1) minerals: naturally occuring inorganic solids possess and orderly internal structure and definite chemical composition.
(2) need to occur naturally, be solid at surface temperature and pressure, possess orderly internal structure, definite chemical composition, inorganic
(3) rock: solid mass of mineralor mineral like matter that occurs naturally
(4) aggregate: combined while properties maintained

3.2. **The composition of minerals.**

(1) every sample of same mineral has same elements
(2) minerals are chemical compounds
(3) ionic compounds have orderly arrangment of oppositely chaged ions

orderly packing of atoms in regularly shaped objects called cyrstals
polymorphs:two minerals can have same chemical composition diff physical charactersistics.i.e graphite and diamond

3.4. **physical properties.**

3.4.1. *Crystal habit.* external expression of mineral that reflects orderly internal arrangment of atoms. When no space restrictions, mineral will form individual crystals with well formed cyrstal faces. growth interrupted by competition for space. results in intergrown mass lacking habit.

lustre is appearance or quality of ligth reflected form surface of mineral, metallic and non metallic, vitreous(glassy), pearly, silky,resinous, earthy(dull)

colour not diagnostic

streak is color in a powdered form. rub against porcelain to see

hardness: resistance to abrasion and scratching. rub one of known hardness to another to get a numerical value on Mohs scale of relative hardness. scale consists of 10 minerals.

cleavage: tendency to break along planes of weak bonding. planes of cleavage when minerals break evenly in multiple directions. defined by number of planes and angles at which they meet. when cleave, break into same geometry

fracture: minerals with chem bonds of same strength can still break in distinctive manner. can break into concboidal, splinters, fibers, unevern

specific gravity: ratio of weight of a mineral to weight of equal volume of water

other properties like taste, elasticity, malleability greasy/soapy feel, magnetism, smell, refraction

3.5. **mineral classes.** most rocks made out of few minerals called rock-forming minerals. eight element compose these: O, Si, Al, Fe, Ca, Na, K, Mg

3.5.1. *Silicates.* silicon and oxygen, most common class

contains one or more common elements needed to produce electrical neutrality.

same fundamental building block of silicon-oxygen tetrahedron. 4 oxygen surroundign silicon. neutralized with addition of cations. whe more added, sharing increases and so does sheet structure

4. Chapter 3

bulk of earth's crust. formed when molten rock solidifies and cools.

magma formed by partial melting . once formed magma rises to sruface buoyantly because it is less dense than the surrounding rocks. molten rock breaking through is a volcanic eruption. lava when on surface

igneous rocks that form when magma solifies at surface alled xtrusive or vulcanic. when amgma loses mobility before reaching surface, crystallizes and creates plutonic instrusive rock. pluton is body of plutonic rock

4.1. **Generating magma from solid rock.** earths crust and mantle mostly solid rock. magma formed at subduciton sones and withing crust. exposed at divergent boudnaries

geothermal gradient: change in temperature as you descend into earth. rocks near melting point b ut still solid

additional heat generated by 1)subduction zone friction between lithosphere plates 2) crustal rocks heated they descend into mantle during subduction. 3) hot mantle rocks can rise and intrude crustal rocks

additional heat generated by 1)subduction zone friction between lithosphere plates 2) crustal rocks heated they descend into mantle during subduction. 3) hot mantle rocks can rise and intrude crustal rocks. rocks near melting point can begin if pressure drops or volatile(fluids, gasses) are introduced.

4.1.1. *role of pressure.* when melting, volume increasing, therefore a decrease in pressure will contributre. called decompression melting. rock ascends due to convective upwelling

4.1.2. *role of volatiles.* water and other volatiles decrease melting temp. wet rock buried at depth has lower melting temperature.

important in generating magma. cool slabs of oceanic lithosphere descned into mantle. Water from subducting crustal rocks driven out by heat and pressure. Migrate into wedge of hot mantle that lies above.

when enough mantle driven mafici(magnesium and ferrum) magma forms rises to surface. may pond below crustal rocks.

5. Chapter 5 –weathering

5.1. **weathering an soil.** external processes: occur at or near earths surface and powered by energy from the sun or Earth's gravity. transform solid rock to into sediment.

internal processes: parts of earth surface gradually elevated