Stratigraphy

Vanderbilt Student Volunteers for Science

2018-2019 VINSE/VSVS Rural

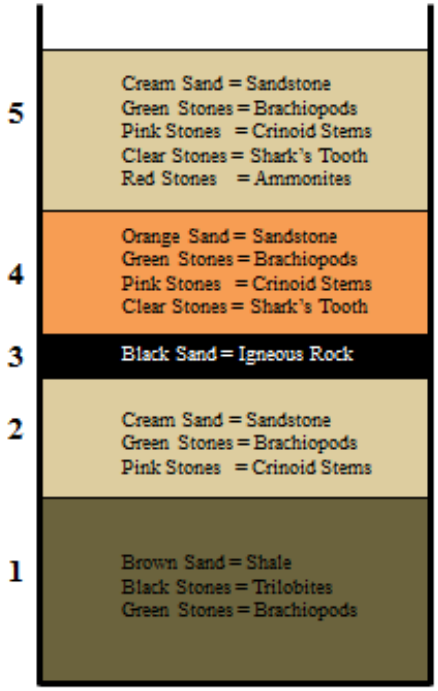
IA. Reviewing Sedimentary Rocks

- *Write key (in bold) terms on board, and write out definitions on board as terms are introduced*

- Sedimentary rock facts:
  - Formed from sediments deposited in oceans, lakes or rivers.
  - Sediments form layers that pile on top of each other.
  - Rock layers are called strata.
  - Common all over the world.
  - Sandstone, limestone, and shale.

IB. Activity - Creating a Model of Sedimentary Layers

- Set up at the front of the class, 1 plate, 1 column, 1 bottle of water, 5 numbered jars of sand:
  - Jar 1: Brown sand containing black and green "stones".
  - Jar 2: White sand containing pink and green "stones".
  - Jar 3: Black sand
  - Jar 4: Orange sand containing pink, green and clear "stones".
  - Jar 5: White sand containing pink, clear, green and red "stones".



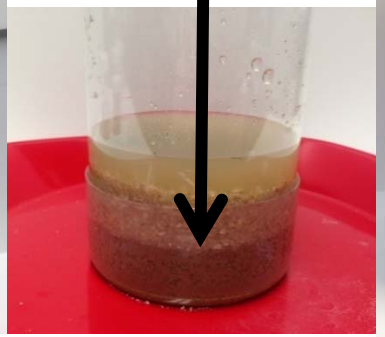
- Draw diagram on board representing column
  - Draw each section of the diagram as it is poured into the column.
  - Add in correct order.

IB. Activity - Creating a Model of Sedimentary Layers (cont.)

- One VSVS member constructs demo column at front of class.
  - Column or jar is on plate to catch spills.
  - Pour container of water into the column.
  - Pour all of the sand and rocks from Jar #1 into the column.
  - Wait until each layer is settled and pour the next layer (jar #2).
  - Continue with all jars, updating the drawing as you go.

- **Explain:** Sediments are deposited in flat, horizontal layers and stay that way unless something disturbs it.



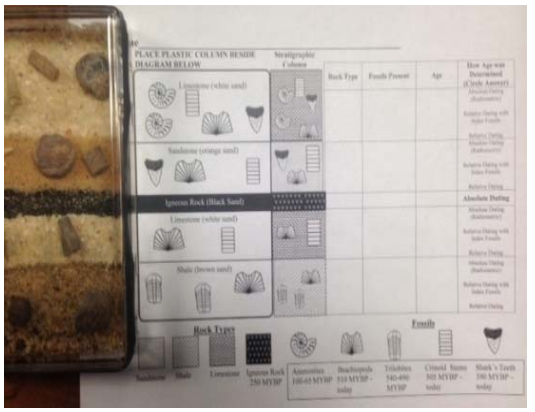

IC. Explaining the Column

Fossils are deposited at the same time the rock material is deposited. Therefore the ages of the fossil and rock in which it is found are the same.

- Tell students to imagine that the process of creating their sand columns took millions of years to occur.
  - Q. Ask students which layer is the oldest in the column.
    - *The bottom layer; it was deposited first and other layers were deposited on top of it.*
  - Q. Ask students which layer is the oldest in the column.
    - *The top layer; it was deposited last, on top of all other layers.*
  - How old are the middle layers? *(You can't tell for sure! But they are older than the top layer and younger than the bottom layer.)*
  - Have students answer Question 2 on their observation sheet.
- *#2. Older layers are _____ in a column of sedimentary layers, while younger layers are _____.*
  - Fossils succeed each other in a definite order – the oldest fossils in a series of layers will be in the lowest layer.

ID. Index Fossils

- Pass out 1 model of rock layers/fossils encased in boxes and 1 “Column Analysis” sheet to each group of students.
  - Help students orient model correctly on observation sheet.
  - Help student match up model with column the teacher created.
  - Tell students names of type of rock and fossils in each layer.
  - Models contain real fossils that are represented by pebbles in their created column.
  - Help students fill in the first two columns on the analysis sheet.



- **Explain that a Stratigraphic Column** is the way geologists represent rock columns – diagram to the right.

ID. Index Fossils cont.

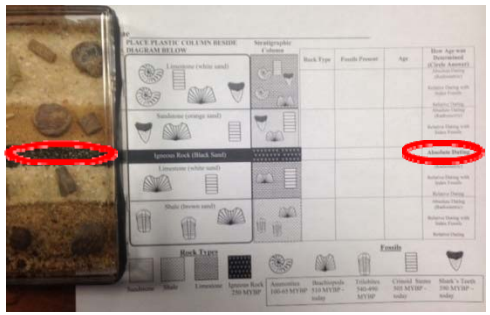
- Tell students that in real sedimentary rocks, some fossils are found in many layers, while some are found in only one layer.
  - Ask students which type of fossil, one found in many layers or one found in only one layer, would be more useful for identifying/finding the age of a rock layer.
    - *Fossils found only in one layer can be used for identifying and finding the age of a rock layer, because they are unique to that layer. They are called* ***Index Fossils***
  - Ask students which fossil(s) in their column would be considered index fossils, and which would not be considered index fossil(s)
    - *Ammonites and trilobites are only found in one layer, so they would be considered index fossils; others in their columns are not.*

ID. Radioactive dating

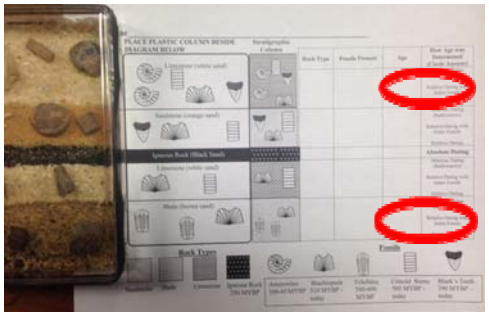
- Tell students to look at layer # 3 in their model – the thin black layer.
  - When there is a dark, skinny layer in a sedimentary rock column, it is usually the result of lava or volcanic ash interrupting a sedimentary rock layer – it is an igneous rock, not a sedimentary rock.
  - Igneous rocks contain radioactive elements like uranium, rubidium, thorium, and potassium – scientists can use these elements to determine the exact age of these rocks!

IE. Finding the Rock Ages in our Column

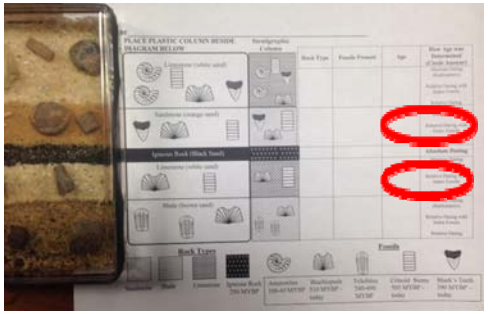
- Tell students they are now going to use their model to determine the ages of the “rock” layers.
  - Write ranges on board as you go through them so students can fill them in in their worksheet.



- Black layer – is an igneous rock and so we can date it via absolute dating with radioactive elements = 250 million years old (in this hypothetical case).



- The top and bottom layers contain index fossils and we know the range they were deposited
  - Ammonites (top layer) - 100 million years ago until 65 million years ago
  - Trilobites (bottom layer) - 540 million years ago until 490 million years ago

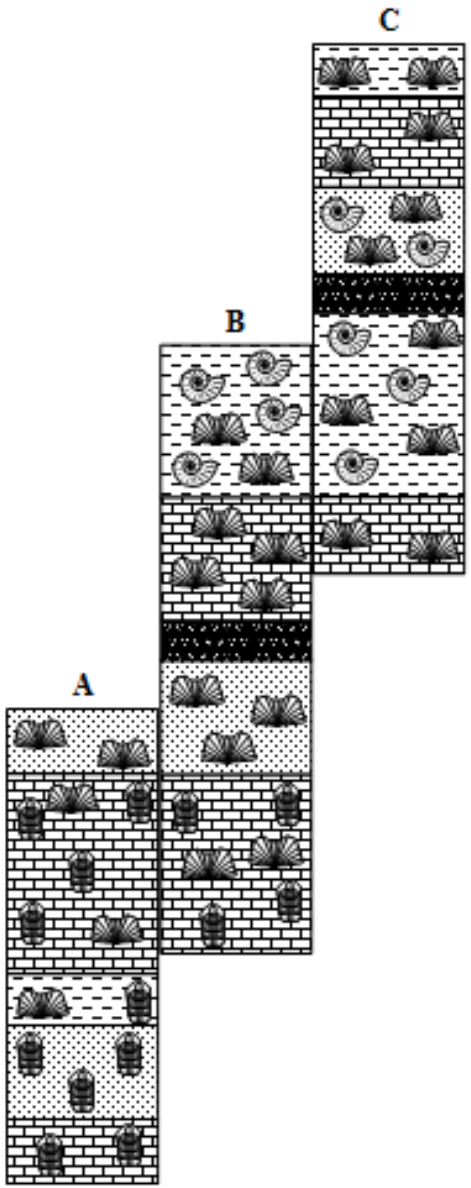


- The other two layers are dated by Relative dating – intervening ranges between the layers on either side.

II. Stratigraphy

- Sedimentary rock layers often stretch across entire continents.
  Sometimes these layers are connected; however, often layers have been removed in some locations by erosion, and some are buried under other layers and can't be seen by us yet.
- Pass out the set of 3 stratigraphic sequences to each student. Tell students to imagine that these are 3 sequences of rocks found in different places around the US.
  - Tell students to find in sequences A and B at least 2 layers whose index fossils and rock types match.
  - Emphasize that the depth of the layers does not have to be the same.
  - Students should place the sequences side-by-side with matching layers touching.
  - Have them repeat the process with sequences B and C.

- Pass out the longer laminated strip (1 per pair) and tell the students that this geological column is the one they have just compiled from their short sequences. This can tell us a lot more about the geologic history of the earth than the individual columns can.



II. Stratigraphy cont.

- Q. Which short strip has the oldest rocks exposed and how do we know?
  - *Location A, because it contains the oldest fossils and has the bottom layers in the geological columns.*
  - These layers still exist at locations B and C, they just haven't been exposed yet.
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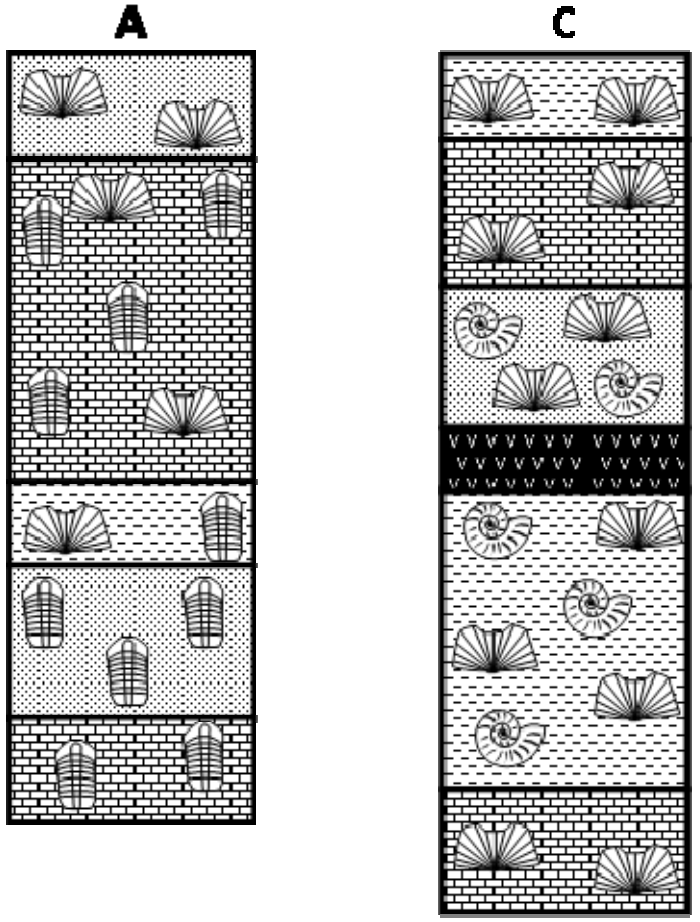
- Q. Which short strip has the youngest rocks exposed and how do we know?
  - *Location C, because it has the top layers in the geological column.*
  - These layers are missing at locations A and B because of erosion.



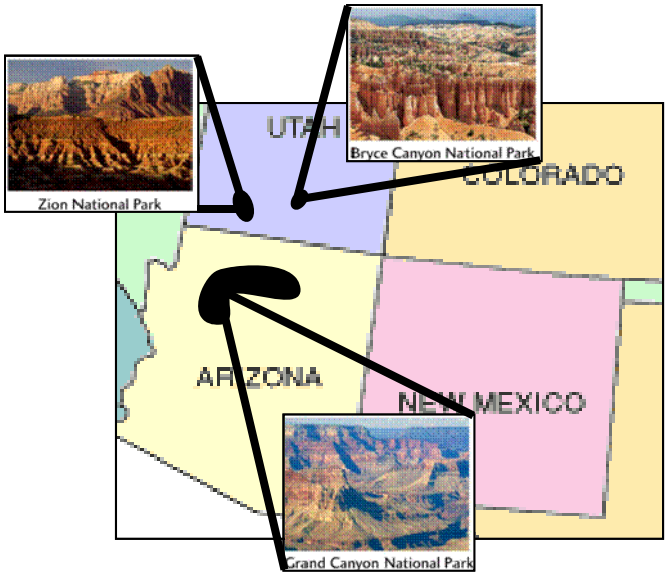
II. Stratigraphy

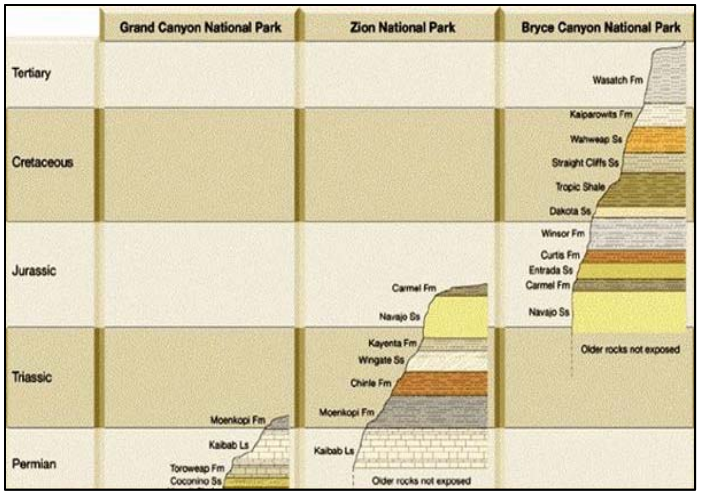
IIB. National Park Rock Sequences

- Pass out the sets of colored stratigraphic columns to students (these have been cut from the columns below, and labeled on the back with respective national parks)

- Students should separate the columns and place them next to the correct national parks

- Point out that stratigraphic columns can correlate even across long distances





III. Timeline of the Earth

- Ask the class if anyone knows how old the earth is.
  - *4.6 billion years old, or 4600 million years old. Write the number out in full on the board so they understand how much time this is (4,600,000,000).*
- Tell students that the timeline of earth's history is called the geologic time scale. We will show them a rope that represents, to scale, this timeline.

- It is divided into eons, which are further divided into eras.
- Note – the string is 19 feet long, so make sure you have enough room to "spread".
  - One VSVS member or student volunteer will hold the string and another will hold the container and walk to the right while removing each eon and stopping when a knot is reached.
- A VSVS member will describe each eon to the students, while another writes the information regarding each eon and era on the board as they are introduced

III. Hadean Eon

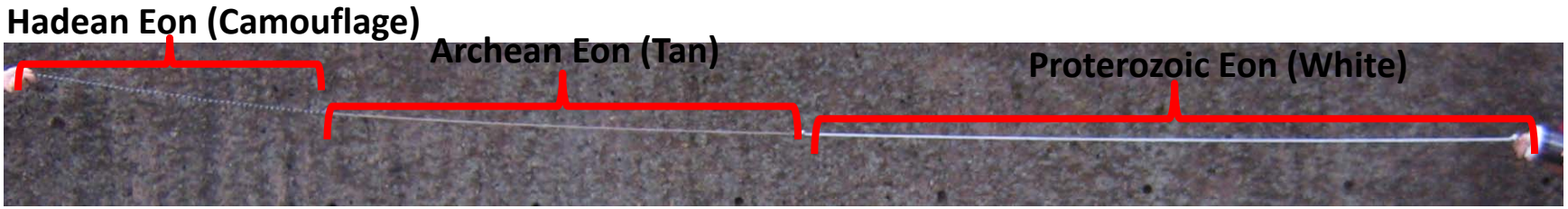
- Pull the first (camouflage) section of the string out & stop as soon as you get to the first knot (between color changes)
- Tell Students:
  - 4.6-3.8 billion years ago
  - **Major event**: the earliest known rocks were formed The oldest Earth rock in North America is found in the Canadian Rockies & is dated at 4030 mill years ago
    - The only known older rocks come from meteorites and the moon
  - Rocks are dated using radioactive isotopes

III. Archean Eon

- Pull the string out until the second knot is reached at the end of the tan section
- Tell Students:
  - 3.8-2.5 billion yrs ago
  - Major event: the first single-celled organism evolved – fossils of these are found in Australia & are given an age of 3770 million yrs

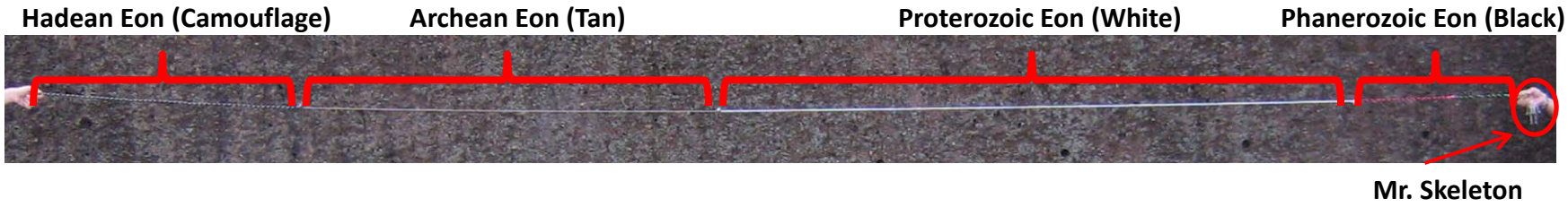
III. Proterozoic Eon

- Pull the string out until the next knot is reached at the end of the white section
- Tell Students:
  - 2.5 billion years – 540 million yrs ago
  - Major event: multi-celled organisms evolved; the earliest multi-celled fossil was found in Michigan & is dated at 2.2 billion years



III. Phanerozoic Eon

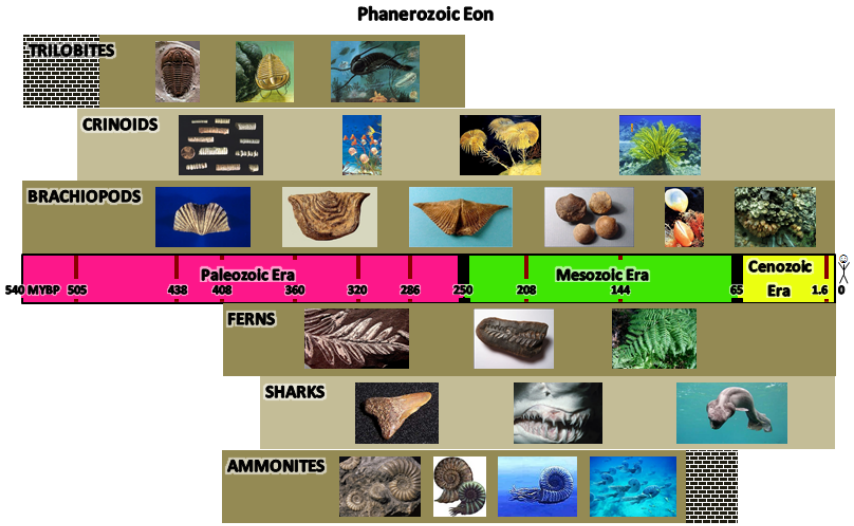
- Pull the string out until the end is reached.
- Tell Students:
  - 540 million years ago – Present day
  - Major events: life evolves from multi-celled organisms to plants, fish, and animals as we know them today
  - Humans only existed in the **very last knot** of the rope (see the dangling skeleton!)
  - The eon is subdivided into 3 smaller time intervals called **eras,** which are color coded with colored string twisted around the black cord



IIIC. Looking at the Phanerozoic Eon Timeline

- Pass out the timeline mats, one per pair of students, while the rope is still stretched out
- Briefly explain the layout of their timeline
    - **The center rectangle** with the numbers, era names, and three different colors is **the time scale** of the Phanerozoic Eon.
    - The **numbers** represent millions of years before present with 0 being present day
    - The **different colors** show the different **eras.** The mat's colors match the rope's colors!

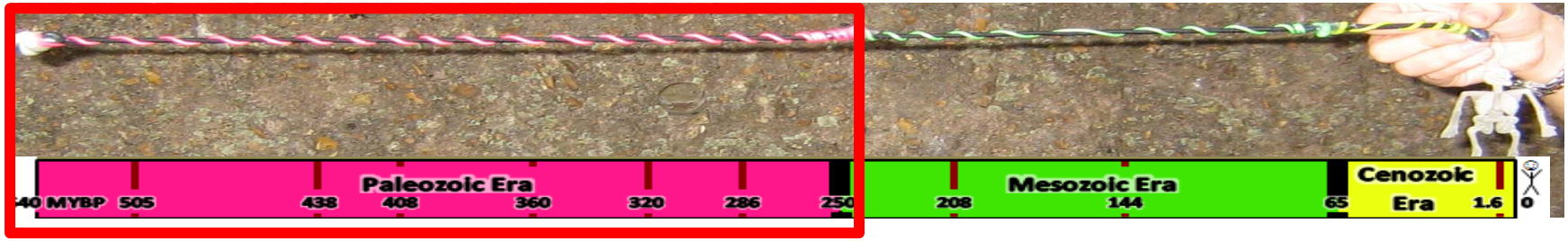
- The **thick black lines** also represent mass extinctions
- **The tan rectangles** correspond to the life spans of the organisms in the rectangles.



IIIC. Paleozoic Era

Pink Sections – The Paleozoic Era:

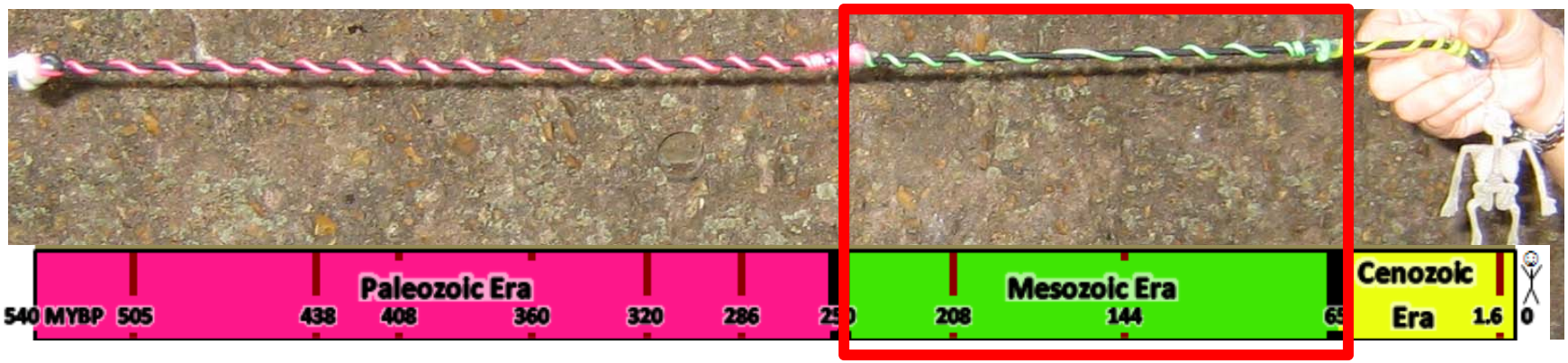
- Invertebrates such as trilobites, brachiopods, crinoids, and ammonites flourished in this era
  - Invertebrates lack a backbone.
- Early fish develop
  - Image of frilled shark, considered a "living fossil" – it still exists but is rarely seen because it lives deep in the sea)
  - Sharks constantly shed their teeth. The skeleton of the shark is cartilaginous and so the teeth (which are bony) are more likely to be found as fossils
- Early land plants develop - ferns
- Early reptiles developed Ends with the largest mass extinction– 90% of all species became extinct.
  - **Make sure students know what extinction means.** *The species will never be alive again.*



IIIC. Mesozoic Era

Green Sections – The Mesozoic Era:

- Age of Reptiles - many major reptile groups were dominant life forms
- Dinosaurs, birds, small mammals, flowering plants, and flies flourished Ends with mass extinction of 50% of all species, including dinosaurs
  - It coincides with the impact of a huge meteorite in Mexico



IIIC. Cenozoic Era

Yellow Sections – The Cenozoic Era:

- **Cenozoic means "recent life".**
- This is the Age of Mammals. Note - Some are already extinct (woolly mammoth, saber-toothed cat.)
- The last knot represents the time that humans have lived on earth.