Name:

Index Fossils and Relative Dating Lab

Part 1 Objectives:
(1) Create a chart to show the range of geologic periods when different cephalopod species lived;
(2) Determine which species of cephalopods are good index fossils;
(3). Use index fossils to determine the relative age of rocks.

Introduction

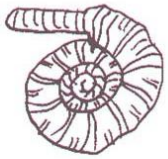
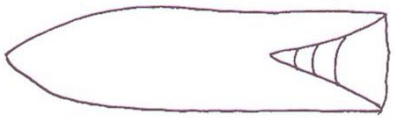
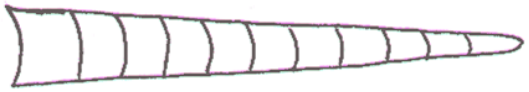
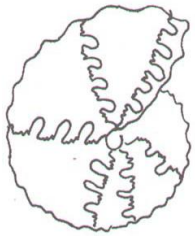
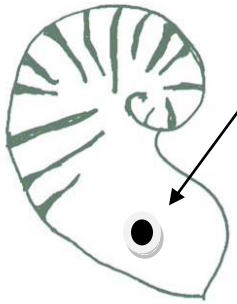
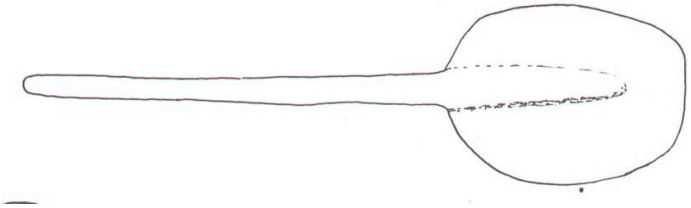
One of the most economically valuable uses of fossils is for finding oil. Oil companies are interested in the age of rocks because oil was produced during certain time periods on Earth. One of the most prolific periods of oil production was during the Cretaceous. During this time, marine algae died and built up in great quantities on the seafloor. When this organic material is buried, it is heated and put under pressure. If this continues to the right temperature and pressure, then oil is produced. The Persian Gulf region is rich in oil because it contains large quantities of rock from this time period. Dating a rock using fossils is called **relative dating**. This is because the rocks are dated relative to each other. For instance, if one rock has a fossil T. rex and another has a fossil Saber Tooth Tiger, the one with the Saber Tooth Tiger is younger because we know that dinosaurs went extinct before large mammals appeared on earth. However, without more advanced technology, namely radioactive dating, we can't figure out exactly how old the T. Rex or the Saber Tooth Tiger are. Ammonites are organisms that lived in the oceans at the same time as the dinosaurs roamed on Earth. They also went extinct with the extinction of the dinosaurs, at the end of the Cretaceous Period. They were very abundant, evolved rapidly, and are easily identifiable. Therefore, they are very useful to geologists who try to identify the age of rock units.

In this activity, you will create a fossil range chart for ammonites and their relatives in the Class Cephalapoda, which includes modern species such as octopuses, squids, cuttlefish, and nautilus. You will then use the information in the chart to determine the age of particular rocks and to predict which rock might contain oil.

Procedure

Make a fossil range chart. Look at the pictures of fossils in figure 1. Each fossil represents an order that contains a variety of genera and species. Underneath each picture is a time range. You will make a bar graph on the sheet provided. Shade in the area that represents the time period during which the fossil existed. For instance, for the Goniatites, shade in everything from the Carboniferous to the Permian (including the Carboniferous and the Permian). When this is complete, you will have made a fossil range chart.

Data Table: Representative Fossils from the Order Cephalopoda and their Geologic ranges.

 **Name: Ammonite** **Time Range: Triassic - Cretaceous**	 **Name: Belemnite** **Time Range: Jurassic - Cretaceous**	 **Name: Orthocone** **Time Range: Ordovician-Triassic**
 **Name: Ceratites** **Time Range: Triassic**	 **Name: Octopods (evidence)** **Time Range: Jurassic - Recent** **Name: Nautiloids** **Time Range: Devonian – Recent**	 **Name: Goniatite** **Time Range: Mississippian-Pennsylvanian**
 **Name: Teuthids (squid)** **Time Range: Devonian- Recent**		

Directions: Shade in the box for the period or periods that each Cephalopod species was alive.

Index Fossil Range Chart

	PALEOZOIC ERA 540 – 245 Ma							**MESOZOIC ERA** 245 – 65 Ma			**CENOZOIC ERA** 65 Ma – Present	
Cephalopod Order	Cambrian Period	Ordovician Period	Silurian Period	Devonian Period	Mississi-pian Period	Pennsyl-vanian Period	Permian Period	Triassic Period	Jurassic Period	Cretaceous Period	Tertiary Period	Quaternary Period
Ammonites												
Belemnites												
Orthocones												
Ceratites												
Nautiloids												
Octopods												
Goniatites												
Teuthids												

Data Analysis Questions

1. If you have a rock with a Ceratite in it, what time period(s) is it from?

2. If you have a rock with Goniatites and Nautiloids in it, what period(s) is it from?

3. If you have a rock with Ammonites, Orthocones, and Teuthids in it, what period(s) is it from?

4. What fossils would you look for to determine if a rock was from the Jurassic?

5. If you find a sedimentary rock that has no Cephalopods in it, can you tell what time period it is from (using the information provided in this lab)? *Why or why not? Provide a scenario to support your answer*

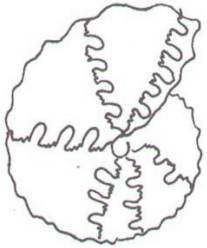
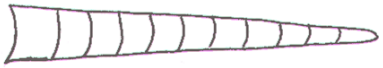
6. Not all index fossils are equal. Which Cephalaopod fossils would be the BEST index fossils for making estimates on rock ages? Support your answer with reasons.

7. On the next page are rock samples A through D. On each sample:
    a. Identify the fossils by name (Label)
    b. Identify the time period(s) the rocks are from (Label).

8. Cephalopods are organisms that lived in the open ocean. During the Cretaceous, a lack of oxygen in ocean basins meant that large deposits of organic material built up. This material came primarily from microorganisms in the ocean water. This material was later buried and eventually became oil. Geologists from oil companies frequently use range charts to help them date rocks so that they might find more oil.

- **Imagine that you are an oil geologist. Of the rocks you dated in question 7, which would you recommend further investigation for oil?**

Questions 7 & 8

Rock Sample A.  	**Fossils Present**	**Estimated Age Range of Rock** **Drill for Oil? (Yes/No)**
Rock Sample B.  	**Fossils Present**	**Estimated Age Range of Rock** **Drill for Oil? (Yes/No)**
Rock Sample C. 	**Fossils Present**	**Estimated Age Range of Rock** **Drill for Oil? (Yes/No)**
Rock Sample D.  	**Fossils Present**	**Estimated Age Range of Rock** **Drill for Oil? (Yes/No)**

Part 2:
Objective: Sequencing layers using index fossils

Materials: two sets of sequence cards in random order (set A: nonsense syllables; set B: sketches of fossils), pencil, paper

Procedure:

- Spread out the GREEN CARDS on the table. Each card represents a SEDIMENTARY ROCK LAYER. The letters on the cards represent FOSSIL SPECIES (Species "T" or Species "C").
- The OLDEST ROCK LAYER is the layer with FOSSIL "T" in it. Now arrange the cards to show how the rock layers would be stacked from oldest to youngest. Use common fossils to help you. Remember, once a species goes extinct it does not return to the rock record. When you finish, you should have a vertical stack of cards with the top card representing the youngest fossils of this rock sequence and the "TC" card at the bottom of the stack representing the oldest fossils.

Results:

9. **Write the order of fossil species from OLDEST → YOUNGEST in the space below. Write each letter only once.**

_____

Oldest → → Most Recent

Interpretation Questions:

10. How do you know that "X" is older than "M"?

11. Explain why "D" in the rock layer represented by DM is the same age as "M."

12. Which fossil species lived a **longer period of time: B or N?**

Part 3: Pink Cards

- **Procedure Set B:**
  Carefully examine the PINK set of cards which have sketches of fossils on them. Each card represents a particular rock layer with a collection of fossils that are found in that particular rock stratum. All of the fossils represented would be found in sedimentary rocks of marine origin. Figure 2-A gives some background information on the individual fossils.
- The oldest rock layer is marked with the letter "M" in the lower left-hand corner. The letters on the other cards have no significance to the sequencing procedure and should be ignored at this time.
- Find a rock layer that has at least one of the fossils you found in the oldest rock layer. This rock layer would be younger as indicated by the appearance of new fossils in the rock stratum. Keep in mind that extinction is forever. Once an organism disappears from the sequence it cannot reappear later. Use this information to sequence the cards in a vertical stack of fossils in rock strata. Arrange them from oldest to youngest with the oldest layer on the bottom and the youngest on top.

Interpretation Questions:

13. Write the order of ROCK LAYERS from OLDEST → YOUNGEST in the space below. Write each letter only once.

Oldest →_____→ Most Recent

14. Which fossil organisms would be the BEST index fossils (to narrow down the age of rocks)? Name **three**. **Explain why they are good index fossils.**

_____ , _____, _____

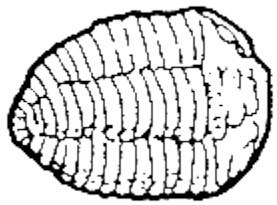
Reason:

15. Name **three** organisms represented that probably could not be used as Index fossils and **explain why.**

_____ , _____, _____

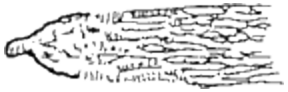
Reason:

Table 2: Sketches of Marine Fossil Organisms (Not to Scale)

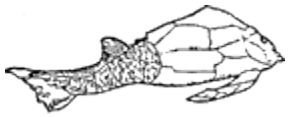
		
NAME: Brachiopod PHYLUM: Brachiopoda DESCRIPTION: "Lampshells"; exclusively marine organisms with soft bodies and bivalve shells; many living species	NAME: Trilobite PHYLUM: Arthropoda DESCRIPTION: Three-lobed body; burrowing, crawling, and swimming forms; extinct	NAME: Eurypterid PHYLUM: Arthropoda DESCRIPTION: Many were large (a few rare species were 5 feet in length); crawling and swimming forms; extinct

NAME: Graptolite
PHYLUM: Chordata
DESCRIPTION: Primitive form of chordate; floating form with branched stalks; extinct

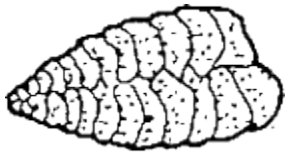
NAME: Horn coral
PHYLUM: Coelenterata (Cnidaria)
DESCRIPTION: Jellyfish relative with stony (Cnidaria)(calcareous) exoskeleton found in reef environments; extinct



NAME: Crinoid
PHYLUM: Echinodermata
DESCRIPTION: Multibranched relative of starfish; lives attached to the ocean bottom; some living species ("sea lilies")



NAME: Placoderm
PHYLUM: Vertebrata
DESCRIPTION: Primitive armored fish; extinct



NAME: Foraminifera (microscopic type)
PHYLUM: Protozoa (Sarcodina)
DESCRIPTION: Shelled, amoeba-like organism

NAME: Gastropod
PHYLUM: Mollusca
DESCRIPTION: Snails and relatives; many living species

NAME: Pelecypod
PHYLUM: Mollusca
DESCRIPTION:
Clams and oysters; many living species

NAME: Ammonite
PHYLUM: Mollusca
DESCRIPTION:
Squid-like animal with coiled, chambered shell; related to modern-day Nautilus

NAME: Icthyosaur
PHYLUM: Vertebrata
DESCRIPTION:
Carnivore; air-breathing aquatic animal; extinct

NAME: Shark's tooth
PHYLUM: Vertebrata
DESCRIPTION:
Cartilage fish; many living species