

Name \_\_\_\_\_



Some Benthic Foraminifera

## Lab 4 Micropaleontology

**Micropaleontology** is the study of fossils so small that they are best studied under a microscope. Microfossils can be brought out of exploratory wells without being damaged by the mechanics of drilling or coring. For this reason they are valuable to the petroleum geologist who uses them to identify rock formations hundreds of meters below the surface. — They are used in age-dating sediments and rock, correlating other fossils, and reconstructing ancient environments (depth, salinity, temperature, etc.). Because they usually occur in huge numbers in sedimentary rocks, they are the most easily accessible fossils. Most marine sedimentary rocks are potentially microfossiliferous. The pyramids of Egypt are made of sedimentary rocks that consist of the calcium carbonate shells (tests) of foraminifera (ocean dwelling single-celled animals/protists).

**Foraminifera**, or "forams", comprise a group of 60-80,000 species. In the Silurian (440 million years ago), forams began secreting calcium carbonate shells (tests). Foram tests range from less than .1 mm to 10 cm. Most are about the size of a pin head. Many species are geologically short-lived and/or are found only in specific marine environments (depth, temperature, etc.) Forams are the principal microfossil used to age-date and correlate marine sedimentary rocks — they are invaluable to the oil industry. It is unusual to drill an oil well without a paleontologist onsite. Based on foram recovery the paleontologist determines the age of the sediments drilled through and how much deeper to drill to reach the oil bearing layer characterized by a particular microfossil assemblage. Billions of dollars have been made on the basis of studying foraminifera.

**1. Benthic forams** (above), tend to be flat on both sides or one side; burrowers tend to be elongate/streamlined. Benthic means that they dwell on the seafloor or burrow into it.

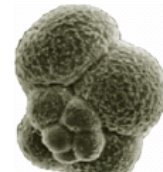
Working in small groups, choose a numbered benthic foram from the boxed samples to observe using the binocular microscope. Your lab instructor will show you how to focus the microscope and how best to illuminate your foram for detailed examination.

Draw your benthic foram in the box below, indicating its number and name.

Repeat: selecting three more forams to draw below. Return your forams to the box.


## 2. Pelagic and Benthic Foram Assemblages

You will examine assemblages of fossil protists called foraminifera, and then determine how sea level changed through time. Foraminifera are protists that secrete calcium carbonate shells around their protoplasm. There are two types: 1) Planktic foraminifera float in the surface waters of oceans and 2) Benthic foraminifera live on the seafloor bottom. After they die, both are preserved in marine sediments. The proportion of shells of planktic:benthic species in the sediments increases from near 0% planktics near the shore to over 90% planktics in deep marine sediments. A typical morphology of a planktic foraminifer has puffy chambers to help it float and a coarse surface with large pores and pits that held spines before its death. Some typical planktic foraminifera look like this (without their spines):



Examine one of the Assemblage #1 slides A-B, and one of the Assemblage #2 slides A-B. These are samples of foraminifera from the ocean floor. Write the letter of your slides below after “#1” and “#2”. Count the number of planktic foraminifera and the number of total specimens (total = planktic + benthic), and determine the percentage of planktic individuals.

	Planktics	Total	Percentage
Assemblage #1			%
Assemblage #2			%

- b. Based on your percentages and the chart on the right, in what range of water depths were the two assemblages of foraminifera deposited?

Water depth range of Assemblage #1

\_\_\_\_\_

Water depth range of Assemblage #2

\_\_\_\_\_

- c. If the two assemblages came from the same locality, and Assemblage #1 is older than Assemblage #2, what did sea level do?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



### 3. $\text{CaCO}_3$ Calcium Carbonate (Calcite) Investigation

Stick a straw into a half-full beaker of saturated  $\text{Ca(OH)}_2$  solution and cover the beaker around the straw with plastic wrap to keep the solution from splattering. Blow gently through the straw into the solution. DON'T SUCK! Calcium hydroxide is harmful if swallowed. Don't hyperventilate; ask your lab partners to help blow. Care should be taken to ensure none splatters into anyone's eyes.

- a. What are you adding to the solution by blowing through the straw? Write it using chemical symbols \_\_\_\_\_

- b. What physical change occurs to the solution as you blow into it?

\_\_\_\_\_

- c. This is a chemical sediment suspended in water. What will happen to these suspended solids over time if the water remains quiet? \_\_\_\_\_

- d. The  $\text{Ca(OH)}_2$  + \_\_\_\_\_ has reacted to produce  $\text{CaCO}_3$  +  $\text{H}_2\text{O}$ . The Carbonate ion,  $\text{CO}_3$ , formed from \_\_\_\_\_.

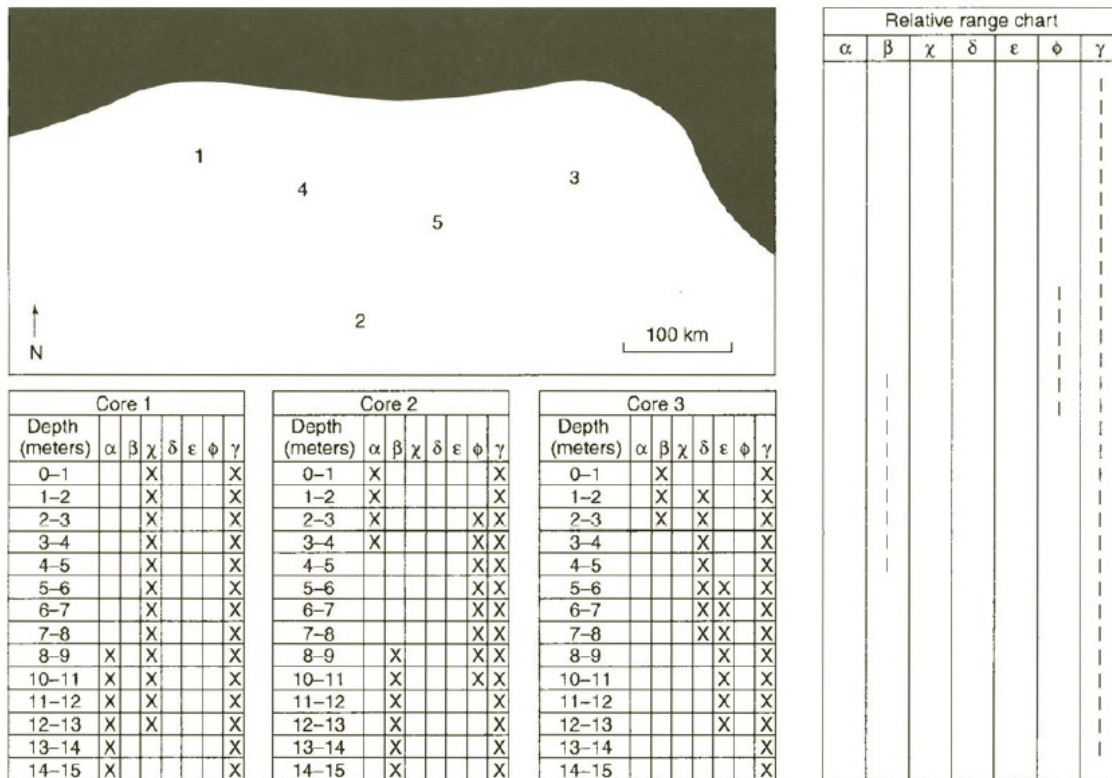
- e. If this chemical compound,  $\text{CaCO}_3$ , had been produced naturally from seawater its mineral name would be \_\_\_\_\_. Fine grained limestone forms in the oceans by a similar chemical reaction. It is called lithographic limestone or micrite.

- f. Many marine invertebrates such as foraminifera, corals, and mollusks, remove carbonate ions from the sea and combine them with calcium ions from the sea to form their exoskeletons. This skeletal carbonate is then deposited upon death onto the seafloor, where it becomes calcareous sediment, which lithifies to form rock called FOSSILIFEROUS L \_\_\_\_\_ S \_\_\_\_\_.

#### 4. Using Microfossils to find oil-bearing sediments

You are a marine geologist examining the potential for petroleum reservoirs within the sedimentary layers of the offshore region below. Three explanatory cores were collected, and the presence or absence of seven different microfossils (symbolized by  $\alpha$ ,  $\beta$ ,  $\chi$ ,  $\delta$ ,  $\varepsilon$ ,  $\Phi$ , and  $\gamma$ ) was reported for each 1-meter interval of each core. Undersea erosion has taken place in the region and sedimentation rates have varied between the sites over time, so do not assume that different core tops or similar depth intervals represent the same age.

- a. Building on the relationships already summarized in the composite range chart, draw in the relative ranges of  $\alpha$ ,  $\chi$ ,  $\delta$ , and  $\epsilon$  using vertical dashed lines.



Hint: Look at the bottom **X** and/or the topmost **X** for each species recovery from a core. Then observe where the top or bottom correlates to a second species recovered from the same core. If there is an overlap where two species existed for a while at the same time, which species dies out earliest and which continues into more recent sediments? Which appears to have appeared earlier in the sedimentary record? Then try to apply (correlate) the same age relationship to the other cores (This is called the pair-wise approach to temporal relations of taxa). Color coding each microfossil: alpha, beta, chi, delta, epsilon, phi, and gamma may help organize the relative range of each species to each of the others.

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- b. While studying the above exploratory cores, you discover that the sediments deposited during the relative time interval when fossil  $\beta$ ,  $\Phi$ , and  $\gamma$  co-occur are rich in petroleum. To try to pump additional petroleum from this layer, you have drilled a fourth well to a depth where microfossils  $\alpha$ ,  $\Phi$ , and  $\gamma$  co-occur and a fifth well to a depth where  $\delta$ ,  $\epsilon$ , and  $\gamma$  co-occur. Using the composite range chart above, determine if each well is sufficiently deep to “tap” this petroleum, and explain your reasoning.

**Hint:** Microfossils recovered from the bottom of the new wells: # 4 and #5, indicate how far back into time they penetrated. Having plotted Species  $\beta$ , Species  $\phi$ , and Species  $\gamma$  from the first three wells on your range chart, find their overlapping time intervals. Remember these three species are in the oil bearing zone.

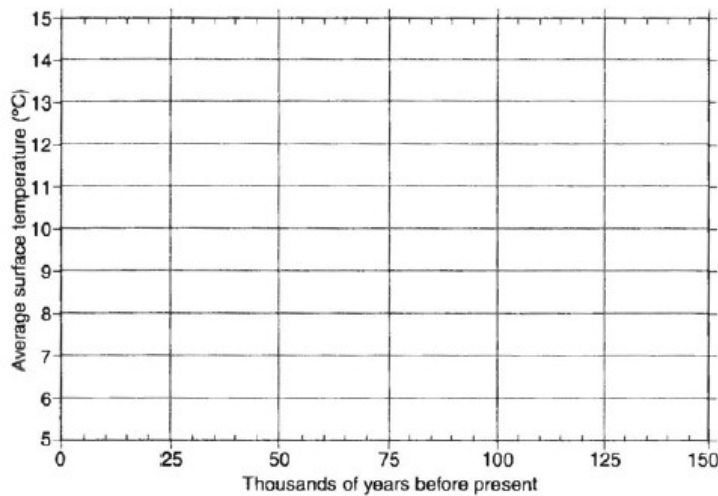
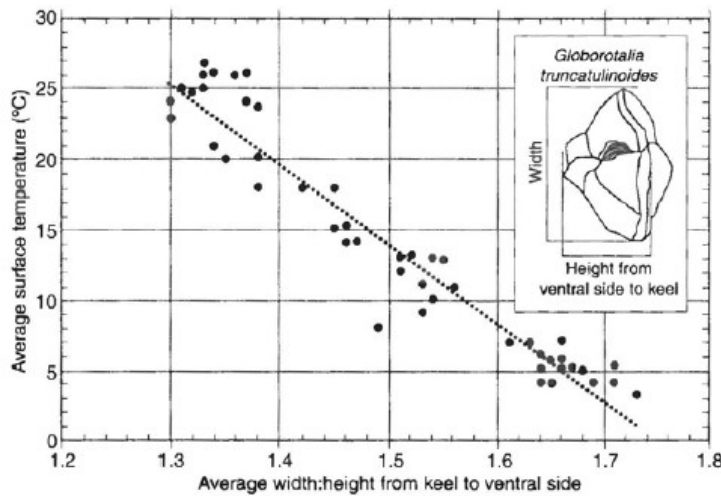
Draw horizontal lines on the range charts from the top and bottom of the species overlaps to chart the depths of well 4 and 5. To indicate the petroleum rich zone draw horizontal lines indicated by overlap of the species that co-occur in the petroleum rich zone..

Your horizontal lines should box in the depth of well 4 and well 5 and the petroleum zone. Label the three boxed depths on the Relative Range Chart as Well 4, Well 5, and \$\$\$\$ for the petroleum rich zone.

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### 5. Using Microfossils to Reconstruct Ancient Environments (paleoenvironments)

$$\text{Temperature} = -55.9 \times (\text{average height:width}) + 97.9$$



Age (kya)	Average Width:Height	Temperature (°C)
0	1.50	
2	1.51	
9	1.55	
13	1.60	
19	1.64	
27	1.62	
32	1.61	
41	1.61	
53	1.59	
59	1.60	
64	1.61	
70	1.58	
81	1.54	
85	1.56	
92	1.56	
99	1.54	
104	1.55	
109	1.56	
110	1.56	
115	1.53	
122	1.50	
127	1.55	
130	1.59	
146	1.62	

- Based on your data when do temperatures appear to be warmest in this region?  
\_\_\_\_\_
- The last glacial age was about 18 kya (18 thousand years ago). Is this general observation consistent with your regional data?  
\_\_\_\_\_
- Over the last 1.8 million years the earth has oscillated between glacial ages (relatively cold, with thick glaciers and polar ice) and inter-glacial ages (relatively warm with diminished /disappearing glaciers and polar ice). According to your data when was there an interglacial period most similar to the present? \_\_\_\_\_



6. Explain why the following attributes make a fossil species good for biostratigraphy (dating sediments and correlating sediments in different locations). Note: these terms are discussed in the on-line reading for this lab.

a. Morphologically distinct \_\_\_\_\_

\_\_\_\_\_

b. Abundant \_\_\_\_\_

\_\_\_\_\_

c. Existed for a Short Interval of Geologic Time \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

d. Wide geographic distribution \_\_\_\_\_

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\_\_\_\_\_

e. Broad environmental tolerance \_\_\_\_\_

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