



Finding Fossils: Biostratigraphy Activity

Teacher Guide

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Background

The aim of this exercise is to show students how we determine the age of a sediment sample on board the *JOIDES Resolution*. Knowing the age of the sediments is important as it tells us how much further we still have to drill to reach our targets, or if we are getting close to dangerous layers of oil and gas. Shipboard scientists use fossilized plankton to work out how old their material is. Several groups of plankton produce external skeletons, and when the plankton dies, their skeletons sink to the seafloor where they are preserved in the sediment. The plankton species that are alive today are very different from those in the past, just like terrestrial animals: millions of years ago we had dinosaurs and flying reptiles, today we have mammals and birds.

Video Resources

- *Introducing the International Ocean Discovery Program*
 - <https://www.youtube.com/watch?v=0nydKlpZdIU&list=PLroDmZEKRHPMctFMzjx-Zg7plqnlqWMjl&index=2&t=242s>
- *How Science Works*
 - <https://www.youtube.com/watch?v=i9tsdAQBcfM&list=PLroDmZEKRHPMctFMzjx-Zg7plqnlqWMjl&index=3&t=0s>
- *PNN Special Report Life on Board*
 - <https://www.youtube.com/watch?v=n0bcloALDFg&list=PLroDmZEKRHPMctFMzjx-Zg7plqnlqWMjl&index=4&t=341s>
- *Finding Fossils*
 - <https://youtu.be/3bCLYXJ4QLs>

Activity Summary

Students form teams to sort through specimen sets to identify the species of their sample (noted on the group's range sheet). Using the range sheet, they determine the possible age of their sample set. The individual teams then come together to discuss the results as a whole class. The individual age ranges based on each team are compared to further constrain the age of the sample. Together, all groups determine the final age range of their sample.



Next Generation Science Standards

- Cross Cutting Concepts
 - Patterns
 - Scale, proportion, quantity
 - Stability and change
- Science and Engineering Practices
 - Developing and using models
 - Analyzing & interpreting data
 - Obtaining, evaluating, and communicating information
- Core Ideas
 - Weather and climate
 - Growth and development of organisms

National Science Education Standards

- Standard A: Unifying Concepts and processes in science
- Standard B: Science as Inquiry

Target Audience

- 9-12
- Undergrad

Time Required

- 1 to 2 class periods

Materials Needed

- Scissors
- Picking grid
- 4 Individual Sample Sets. Sets include:
 - Microfossil Cards
 - Range Sheets:
 - Foraminifera
 - Nannofossils
 - Radiolarians
 - Diatoms



Activity

Plankton fossils are very well preserved in sea floor sediments, so we know a lot about species that are now extinct. We know when and where they lived, and which environment each species preferred. This information is very important when we want to date new sediments. For example, if we find a species that lived between 30 and 35 million years ago, we know that our sample has to be 30 to 35 million years old.

On board the *JOIDES Resolution* we want to get the most accurate age estimate possible. To do this, we collect as many species as we can. Different species have different age ranges, and we can use the overlap between the ranges to further constrain the age. In the example below, sample 1 contains only species A, which existed between 10 and 40 million years. This doesn't help us much as the sample could still be anywhere between 10 and 40 million years old. Sample 2 and 3 are more useful. Sample 2 also contains species B, which existed between 20 and 25 million years ago which narrows our age interval down to this period. It cannot be older or younger than this, as otherwise we would not have found species B. The overlap in sample 3 between species A and C shows that our sample has to be between 10 and 15 million years old,

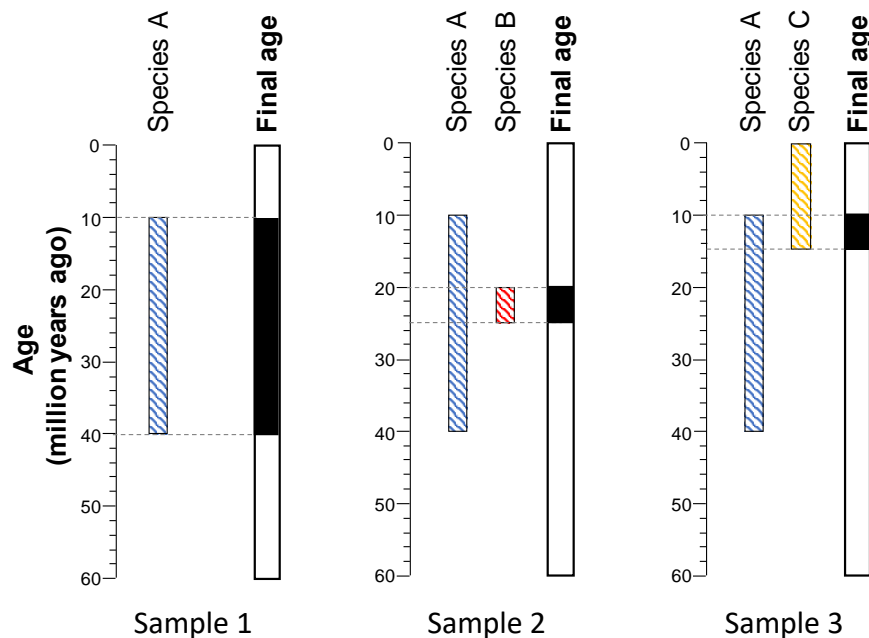


Figure 1. Age control of samples with a single (sample 1) and multiple species (samples 2 and 3).

as species C would not have existed before that, and species A had become extinct afterwards. The age estimates of samples 2 and 3 are a great improvement over the first sample, which shows how important it is to consider as many species as possible.



Exercise

On board the *JOIDES Resolution* we use four groups of microfossils to date our sediments: foraminifera, nannofossils, radiolarians and diatoms. Foraminifera and nannofossils make shells of calcium carbonate, whereas radiolarians and diatoms are made of silica. Their sizes vary too: foraminifera and radiolarians are roughly the size of a grain of sand, but nannofossils are only several micrometres across and diatoms range in size from 2 to 500 micrometres.

Each microfossil group contains so many species that a single person could never memorise all species of all four groups. For that reason, each expedition employs teams of scientists who specialise in a particular group. Working together, the four teams study all species of their groups present in the sediments, and so determine the smallest possible age range for their samples.

In this exercise the students split up in four teams, each team studying either foraminifera, nannofossils, radiolarians or diatoms. Every team gets the same sample with all four microfossil groups present. First, the teams will select 'their' microfossils from the stack. Using their fossil group's range chart, the students then determine the possible age range of the sample based on their microfossil group. When multiple species are present, they can use the overlap of the species' ranges to constrain the sample's age further (see Figure 1). When all teams have done this, they get together to discuss their results and further constrain the sample's age. Age estimates will vary per group. The differences are used to provide the final age estimate: the interval where all microfossil groups' age ranges overlap.

Materials

- Print the "Picking Slide Grid" (1) 11x17 sheet. If this size is not an option, you can print (2) 8.5x11 sheets and tape them together in the middle.
- Print the "Sample 1 microfossil card set" on 8.5x11 paper and cut out each microfossil card. Laminating the cards will make them more durable.
- Print the "Sample 1 Range Sheets" on 8.5x11 paper (4 total per set).
- Repeat for each sample set