



Part 2. Plotting marine oxygen isotope data in Excel.

Step 1. View the source of the data. Using a web browser, connect to NOAA's [Paleoclimatology Program Homepage](#) (a Google search will take you to this). This website provides links to the data sets used by climate scientists to understand the history of climate change, or paleoclimatology.

A. From there, go to [Paleocean](#). This page includes a search engine, from which scientists can explore the types of data available for studying paleoceanography, information about changes in the ocean over geologic time scales. Select the [Paleoceanography Search Engine](#). When you arrive at the Search Engine page, type "odp" into the space for "Site" and click the search button. ODP stands for the Ocean Drilling Program, which was a United States-sponsored program aimed at extracting paleoclimatic information from the oceans through the retrieval of long cores of deep marine sediment.

B. Scroll down to ODP677. This represents site 677 of the ODP, where an ocean drilling platform was used to retrieve a core of deep marine sediment. Click on "Astronomical Timescale for the lower Pleistocene"; this should open a text file in your web browser.

3. Read the text file you created on the website. Where was ODP core 677 retrieved? What was the water depth?

4. What type of sediment forms in this water depth? For the upper two meters of the core, approximately how many years are represented by 10 cm of sediment?

5. How thick is ODP core 677? How much geologic time is represented by the entire core?

Step 2. Organize the data. Open the Excel worksheet and save a copy to your computer.

A. The Excel worksheet does not include all of the data you viewed in the text file. Instead, it displays only the data for fossils of benthic foraminiferids in the genera *Uvig* and *Uvigorid*. Oxygen isotopes of planktonic foraminiferids (floating forams) indicate sea-surface temperature, whereas oxygen isotopes of benthic forams (bottom dwellers) indicate changes in ice volume. That is, the benthic foram $\delta^{18}\text{O}$ is a proxy for the size of ice sheets.



B. Insert a new column between columns B and C, and enter the heading "sample age (kyr)." Compute ages of each sample in thousands of years. Below the heading, enter the equation " $=b2/1000$ ". Copy and paste this equation downward to all cells in the column.

Step 3. Plot the data. Create an X-Y plot of $\delta^{18}\text{O}$ (on the y-axis) as a function of age (on the x-axis) for the past 2 million years.

A. Be sure to use the Scatter Plot option with straight lines, no point markers.

B. The title of the plot should be " $\delta^{18}\text{O}$ benthics (Uvig.) ODP 677". The name for the x-axis should be "Age (kyr)", and the name for the y-axis should be " $\delta^{18}\text{O}$ (‰)". Make the plot a separate page in your Excel worksheet.

C. The Y-axis should have a minimum value of 3 (not the default which is 0) and a maximum value of 5.5, and the X-axis should have a maximum value of 2000 kyr. Display the values on the Y-axis in reverse order. You now have a neat plot of $\delta^{18}\text{O}$ variations at ODP site 677 as a function of time over the past 2 million years. Copy and paste it here:



Part 3. Interpreting the Data

6. What do intervals of high $\delta^{18}\text{O}$ values represent? What do intervals of low $\delta^{18}\text{O}$ values represent?

7. What is the range through which $\delta^{18}\text{O}$ values fluctuate between 500 kyr ago and the present?

8. Based on this $\delta^{18}\text{O}$ record, intervals of greatest ice volume and least ice volume have been identified. Intervals of greatest ice volume are termed **glaciations**, whereas intervals of least ice volume are termed **interglacials**. These shifts in climate are mirrored by isotope “excursions” (changes). Paste your graph here again:

9. Of the isotope excursions shown above/on your graph, circle the five that display the greatest ice volume in blue.

10. Now identify the five lowest $\delta^{18}\text{O}$ values on the curve over the past 500 kyr, the isotopic excursions that represent the interglacials. Circle them in red.



11. Climate scientists can also take a broader view of ice volume changes, by considering the long term trends in the $\delta^{18}\text{O}$ curve. Consider the past 150 kyr of the curve. How many years of overall ice growth occur between the minimum $\delta^{18}\text{O}$ value during these 150 kyr?

12. Now, consider the decline in $\delta^{18}\text{O}$ values that occurs at the end of the glaciations and the beginning of the interglacials. How many years of ice decay occur at these two boundaries?

13. Based on your knowledge of the processes by which ice sheets grow and decay, explain the difference in duration of periods of ice sheet growth and ice sheet decay.

14. Given your answer to question #13, do you believe that the current trend of ice sheet melting in Greenland and Antarctica is of immediate concern? Explain your answer.