Lab 18. Equatorial Deep-Sea Sedimentation

Write your answers on a separate sheet of paper

In this lab you will look at sediment thickness in the equatorial Pacific Ocean. The exercise is based on a paper by Mitchell et al. (Paleoceanography, 18(2) doi10.1029/2002PA000828, 2003).

The equatorial Pacific is a region of high biological productivity due to upwelling and high biogenic sedimentation rates. Absolute plate velocities in the central equatorial Pacific have a northward component so that regions that lie on the equator today will be at northern latitudes in the future (Fig. 1).

There are quite a few drill holes in the region (Fig. 2) and in 1997 scientists collected two reflection profiles extending northward from the equator. We will be looking at the eastern profile that extends from hole 72 to hole 1218 (Fig. 2).

Fig. 3 shows the seismic profile that passes near hole 574. The shallowest reflector is the seafloor, and other reflectors have been identified and named by colors. These reflectors can be followed throughout the whole region.

Fig. 4 shows the biostratigraphy of hole 574 with the location and ages of the reflectors marked. The sediments are dominantly calcareous.

Fig. 5 shows the height of reflectors relative to reflector yellow (Y) for the eastern profile. To measure the thickness of a unit between two reflectors you need to measure the distance between the corresponding lines.

(a) Suggest reasons why the thicknesses of the sedimentary units in Fig. 5 show short wavelength (< 1 degree or 111 km) fluctuations.

(b) Compute the sediment accumulation rate (in m/Myr) for each sedimentary unit using the average thickness of each unit between 0 and 4° N and the known ages. Has the accumulation rate changed with time? If so, suggest reasons why.

(c) In a simple model of equatorial upwelling and productivity, the highest sedimentation rates are expected on the equator.
   (i) Make a plot of the latitude of the highest sedimentation rate against the average age of each section and use its slope to estimate the north-south component of the absolute plate velocity.
   (ii) Compare your computed value to that given by the UNAVCO Plate Motion Calculator for the location of hole 573. The calculator is available at http://www.unavco.org/community_science/science-support/crustal_motion/dxdt/ (or just Google “plate motion calculator”).
   (iii) Suggest reasons for the scatter in the plot you created and the agreement (or not) with the Plate Motion Calculator.
Fig. 1. Map of the Earth showing absolute plate velocities. Source: unavco.org

Fig. 2. Map of the central Pacific equatorial region. The bold lines (in a V shape) show the location of two seismic reflection lines; we are looking at the eastern line. Contours show sediment thickness (contour interval 50 m). Boxed numbers and filled circles indicate drill holes. Numbers along the top of the map and dotted lines and show seafloor spreading isochrons in Ma.
Fig. 3. Seismic reflection profile that passes through DSDP hole 574 showing reflectors identified as Green (G), blue (B), purple (P), red (R), lavender (L), yellow (Y) and orange (O).
Fig 4. A bio-stratigraphic section for DSDP hole 574 indicating the location and age of the seismic reflections shown in Fig. 3.
Fig. 5. Location in meters relative to reflector Y (yellow) of overlying reflectors and the seafloor along the eastern seismic profile shown in Fig. 2 (i.e., from hole 72 to hole 1281).