

Applications of a method to detect varved sediments

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Studies of lacustrine deposits, especially on varved sediments, have further clarified the high-resolution record of paleoenvironments. Varved sediments are very useful for these studies because they are expected to contain annual records of depositional environments. In order to obtain annual records such as annual thickness, color tones, and chemical compositions, at the very least, it is necessary to detect the boundaries of annual bands. In addition, the detection and measurements should be reproducible.

Methods to measure boundaries of varved sediments are divided into two main categories: (1) measurement by visual judgment and (2) measurement by image analyses. The latter method uses photographs of the sediment, soft-X ray images, element maps, and so on. In order to detect boundaries, a threshold value, wavelet analysis, and wave analyses of the gray value of images have been previously used. While the visual judgment method has the disadvantages of human error and criteria, the image analysis method also has limitations as follows: one threshold value cannot be used for all locations in successive images; this method is dependent on the resolution of images, and it is affected by noise in the image-values.

In this study, we used a new method to detect the boundaries of banded deposits using the following procedure: (1) smooth the images, (2) calculate the inclination of "gray-value map" of the images, (3) calculate a mid-value in one wavelength of the "gray-value wave" in the map, and (4) detect a boundary as a point of the maximum inclination around the mid-value. The result obtained using this method shows well-defined "boundary map" of the banded deposits, similar to the result obtained by visual judgment. Using this method, internal information, such as the transmittance value of soft-X ray in a lamina, can also be digitized like a lamina thickness. Since a time-series of lamina thickness and internal information of the lamina can be calculated based on this method, lamina-by-lamina facies analysis, such as that performed for detection of flood deposits, can be employed in studying varved deposits automatically and quickly.

Keywords: varved sediments, image analysis, time-series, soft-X ray, diatomite