

## Sedimentary disturbance as paleoenvironmental proxies recorded in Lake Suigetsu, central Japan

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Geological archives, such as sediments, ice core, and stalagmites, are rich source of information about past earth-surface processes. These archives record palaeoenvironmental changes as fluctuations of physical, biological, and chemical properties. Sediments are notably a key archive for providing a link between past and present earth-surface processes without being restricted by settings, such as latitude and geology. However, actual sedimentary archives are rarely preserved in initial condition because of bioturbation. In general, the intensity is affected by the paleo-sedimentary environments such as dissolved oxygen and temperature, indicating the intensity of the sedimentary disturbance can be regarded as rich source of information about paleoenvironment. In this study, we have reconstructed sedimentary disturbance from varved structures in lake Suigetsu, central Japan.

Lake Suigetsu (35°35'N, 135°53'E, 0 m a.s.l.), Fukui prefecture, central Japan, is one of the Mikata Five lakes, which measures 3 km east-west by 3 km north-south and the maximum water depth of ca. 34 m. Lake Suigetsu preserves annually laminated sediments over the last ca. 70 kyr with a significant number of event layers. The visibility of the laminae is not homogeneous and varies depending on the age. Two long cores (SG93, SG06) have previously been recovered, and an exceptionally precise age model has been established through a combination of over 800 radiocarbon dates and high precision varve counting. In 2014, a new core (SG14) was recovered by the Fukui prefectural government from a point ca. 320 m to the east of the SG06 coring site. An age model of the SG14 core was established by visual correlation to the well-dated SG06 core using event layers.

Sedimentary disturbance intensity refers to the relative amount of disturbed sediments, indicating estimation of the initial condition is one of the key to the reconstruction. In this study, we reconstructed relative sedimentary disturbance from varved structures on the basis of image analysis using high-resolution sedimentary core images. Because the sediments oxidise rapidly after collection, we promptly cut the cores in half and took high-resolution photographs before the colours changed under controlled, uniform lighting conditions in a darkroom.

The disturbance of the lamination structures can be regarded as the dividing process of a line segment in a 'broken-stick model'. When a line segment is divided at random points, the length of divided lines follows the exponential distribution with parameter  $\lambda$ . Here,  $\lambda$  value of exponential distribution is a reciprocal of average lamina length and can be regarded as an index of the sedimentary disturbance intensity. In this study, we measured natural lamina length of varved sediments from images and calculated  $\lambda$  values as disturbance intensities.

Reconstructed  $\lambda$  value fluctuations mirrors described facies change, resulting the index can be regarded as a better index for interpreting the facies. The value fluctuates with ten millennial-scale are synchronous with NGRIP  $\delta^{18}O$  fluctuation, especially 15 to 35 ka. The centennial to millennial fluctuations are sometimes matched with that of NGRIP. These results indicate the  $\lambda$  values probably reflect at least paleoclimate changes. As a result, reconstructed  $\lambda$  values not only provide

facies proxy but also are good indicator of the paleoenvironmental proxies.

Keywords: Suigetsu, varve, bioturbation, image analysis