Recurrence interval and magnitude of flood and earthquake events recorded in varved lacustrine diatomites in Japan

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Recurrence intervals and magnitudes of catastrophic events evaluated from continuous deposits provide essential information for paleoenvironmental analyses and disaster defense. The slope failures induced by an earthquake can deposit an event bed as a turbidite, a slide deposit, or a debris flow deposit. A river flow bearing sediment particles entrained by a flood can flow into a water body and deposit a flood-induced bed. Varved lacustrine deposits are one of the most suitable sedimentary deposits for evaluations of recurrence intervals and magnitudes of catastrophic events because high-resolution recurrence times can be obtained from varved deposits and because disturbances of these deposits are limited. However, a few difficulties associated with the identification of event types and statistical limitations of obtaining the event number remain because most studies using varved lacustrine deposits have focused mainly on analysis of sedimentary cores obtained from modern lakes. The middle Pleistocene Hiruzenbara Formation, distributed in Hiruzenbara, Maniwa City, Okayama Prefecture, Japan, includes a varved diatomite deposited in a paleo-dammed lake. In the Hiruzenbara Formation, slope failures and flood deposits can be identified easily at excavated mining pits and can be traced for a few hundreds of meters to as much a kilometer between pits. Additionally, varved lacustrine deposits of the Pleistocene Miyajima Formation distributed in Nasushiobara City, Tochigi Prefecture, include many event deposits showing various sedimentary facies. In this study, we evaluated recurrence intervals and magnitudes of event deposits in varved lacustrine deposits of these formations.
The results of the study revealed that recurrence intervals of both slope-failure and flood deposits in the formations show log-normal distributions that change stratigraphically and with location. On the other hand, bed thickness distributions, suggesting event magnitudes, show a difference between the event types. The flood-induced event type often approximates a power-law distribution, whereas the slope-failure-induced type shows a log-normal distribution. Because very thin (1 to a few mm) flood-induced event deposits can be deposited widely and be well preserved in the formations, the bed thickness distributions of flood-induced deposits directly reflect power law distributions of flood event magnitudes. On the other hand, due to changeable sedimentary facies, bed thicknesses, and horizontal distributions of slope failure deposits, especially the rapid decline of their thickness, the thickness distributions of slope failure deposits show log-normal distributions. Specifically, bed thicknesses of slope failure deposits could not show event magnitudes.

Keywords: sediment gravity flow deposit, flood deposit, slope failure deposit, lacustrine deposit, varve deposit, Hiruzenbara Formation

