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Correlation of paleo-tsunami layers based on grain size and sediment composition, eastern Hokkaido

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Geological study of tsunami deposits is the most reliable method to reconstruct properties of paleo-tsunamis along the Kuril trench because there are no historical records on earthquakes before the 19th century in eastern Hokkaido. Correlation of event layers is needed to discuss the scale and behavior of paleo-tsunami. In general, the correlation of a tsunami layer is based on its thickness, depositional structures, marker tephras, and radiometric ages. Thickness and depositional structures are, however, affected by micro-topography. Thus, the tsunami deposits extend over a distance of hundreds meters are difficult to correlate. On the Pacific coast of eastern Hokkaido, only few marker tephras are available and are insufficient for chronology before the 17th century. In spite of recent developments of radiocarbon dating, the error of measurement often exceeds several centuries. In many cases, no dating samples are available. The present study attempts to correlate tsunami layers on the basis of the particle size distribution with a precision of 1/16 phi, component materials, diatom assemblage, and chemical composition of volcanic glass and orthopyroxene. Particle size distribution was measured with Camsizer (Retsch Inc.).

Field surveys were done on five peat lands in eastern Hokkaido; Urahoro, Kinashibetsu, Onbetsu, Akkeshi, and Nemuro. Deposits were excavated using the Geoslicer (100 and 150 cm length). The tsunami sand samples were taken from every two cm and from every sub-unit.

Between Tarumae-c tephra (Ta-c, ca. 2700 yBP) and Komagatake-c2 tephra (Ko-c2, AD 1694), eight sandy layers were identified at Urahoro (U1 - U8), two layers at Kinashibetsu (K1 and K2), four layers at Onbetsu (O1 - O4), two layers at Akkeshi (A1 and A2), and seven layers at Nemuro (N1 - N7). These layers were recognized as paleo-tsunami deposits, because they contained marine and blackish diatoms and well-rounded sand grains. Their grain size distribution and mineral composition are similar to those of recent beach and coastal dune sediments. Most tsunami layers can be correlated along one transect on the basis of precise grain size distribution and mineral composition. Their variation between layers is greater than that between sites. However, sand samples collected from inland sites contain more fine grains and light minerals than samples from coastal sites. Additionally, the U1 layer in Urahoro is distinguished from others by the appearance of much orthopyroxene. The variation of mineral composition implies difference of the coastal environment, likely difference of season.

Correlation of tsunami layers suggests that U1, U2, U5, and U8 are distributed more widely than other tsunami layers in Urahoro. Likewise, widely distributed layers are O3, O1, and O2 in Onbetsu, and N2, N1, N4, and N7 in Nemuro, in that order.

At present we cannot correlate tsunami layers across five regions. However, the tsunami layers in Kinashibetsu, Onbetsu, and Akkeshi are likely correlated with thick tsunami deposits in Urahoro and Nemuro on the basis of the stratigraphic relationships between the sand layers and marker tephras.

In Nemuro area, upper sand layers contain more marine and brackish diatoms. In Kinashibetsu, Onbetsu, and Akkeshi, thickness of upper sand layers are greater than those of lower layers. These areas likely show decreasing resistance to tsunami attack.

Keywords: Tsunami deposit, Correlation, Grain size, Mineral composition, Pacific coast of Hokkaido