Coastal uplift associated with great earthquake along the Pacific coast of eastern Hokkaido –17th-century event–

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Geodesy and geology show conflicting coastal movement. In geodesy, the coast of eastern Hokkaido has a rapid subsidence of 8-9 mm/year since 1900. In contrast, geology records repetition of seven sudden uplifts during the past 2500 years, with the most recent uplift in the 17th century.

Extensive tsunami sand sheet has indicated multi-segment occurred in the 17th century (Nanayama et al. 2003). Nearly synchronous date to the 17th-century uplift event, Kiritappu has the sheet extended about 3 km from the coast, much further than historic tsunami such as the 1952 Tokachi-oki earthquake. The source of the tsunami was simulated by tsunami earthquake and multi-segment earthquake models. Among the models with different wavelength, only multi-segment model can explain tsunami inundation areas. In this paper, we report new geological evidence of a coastal uplift from the afterslip of a 17th-century earthquake along the southern Kuril trench.

The 17th century uplift discussed here is recorded along a 100 km-long segment of the Pacific coast in eastern Hokkaido. The uplift results in peat-over-mud changes in the deposits of Mochirippu. The Mochirippu, an embayment connecting to the sea only by a narrow entrance, has such stratigraphic evidence shortly below a tephra (Ta-b) of which origin is historic eruption of Tarumai volcano in 1667. Further below the peat-over-mud contacts, a sand sheet is interbedded with mud deposits.

Using tephra as a time line, the sand sheet probably originates from the tsunami of 17th century reported in Kiritappu and the other areas along the Pacific coast of eastern Hokkaido. First evidence is microfossils in the sand sheet. The sand contains many marine-origin fossils, such as marine planktonic and benthic diatoms, sponge spiculae, and radiolarians. Secondly, the sheet shows grading from bottom to top of the layer, and thickness of the sand sheet decreases drastically toward inland. Finally, relative position of the sand and tephra Ta-b is the same as 17th century tsunami sand established in the other areas. Thus relationships between tephra, peat-over-mud contacts, and tsunami sand together indicate that the uplift of 17th century postdates the tsunami. Presence of very thin mud layer means time lag between the uplift and the tsunami. This is probably a few decades on the authority of accumulation rate of peat and mud.

We reconstructed changes in altitude of the coast using diatom fossil assemblages before and after the earthquake event. Changes in the estimated altitude produce steady subsidence before deposition of 17th century tsunami sand. Conversely, after the tsunami, the coastal altitude shows a gradual uplift. These symmetric trends are probably interseismic coastal subsidence and the postseismic uplift. The uplift with the amount of at least 0.9 m is slowly continuous until at least 1667. The slow, over 10 years according to thickness of the mud and peat between tsunami sand and 1667 tephra, uplift indicates postseismic crustal deformation.