Tsunami deposits: their sedimentary characters and paleoseismological importances

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Tsunami deposits can provide important evidence of paleo-earthquakes. However, sedimentary features of tsunami deposits have not been well established yet. We examined sedimentary facies, structure and grain size distribution of tsunami deposits from the 1993 Hokkaido-Nansei-Oki earthquake and the 1741 Oshima-Oshima eruption along the western coast of Oshima Peninsula, southwestern Hokkaido.

The 1993 tsunami of July 12th, 1993, left continuous onshore sand deposits along the west coast of peninsula. After the tsunami, we found tsunami deposits along the estuary of Usubetsu River at Taisei. These consist of mainly medium to fine grained marine sands with gravels. The thickness decreases with landward distance from the shoreline, and finally they pinch out like a lenticular shape at the most upper limit of tsunami run-up. The deposits can be grouped into four sedimentary units, Units 1 through 4 (lower units) and Unit 4 (upper unit). Each of these units are bounded by erosional bases, and interpreted as deposited by up flow of first run-up (Unit 1), return flow of first run-up (Unit 2), up flow of second run-up (Unit 3) and return flow of second run-up (Unit 4), respectively by current directions. The upper unit (Unit 4) was more widely distributed and associated with coarser grains than the lower units (Units 1-3), because the second run-up was larger than the first run-up. Furthermore, Unit 4 was more widely distributed than Unit 3, because the return flow eroded the up flow deposits.

On Oshima-Oshima, a small volcanic island southwest off Hokkaido, a violent eruption and sector collapse occurred on August 29th, 1741, and very destructive tsunami was also documented in this region. The 1741 tsunami deposits were found by Nishimura et al. (2000) along the Ayukawa Coast at Kumaishi. We tried new trench survey and studied sedimentary structures in detail. These sand layers consist of mainly medium to fine grained marine sands with gravels. The thickness decreases with landward distance from the shoreline. The deposits can be grouped into two sedimentary units, Unit I (upper unit) and Unit II (lower units). Each of two units are bounded by erosional bases, and interpreted as deposited by up flow (Unit I) and return flow (Unit II) by current directions.

Furthermore, we tried to study prehistorical tsunami deposits in the eastern Hokkaido Pacific coast area according to sedimentary characters of 1993 tsunami deposit. Then, we found much postulated tsunami sand layers from the past 9000 years are preserved in marshes and lake bottoms on the 100 km long coast of Hokkaido along the Kuril subduction zone.

At Kiritappu Marsh, marine fossils of sand sheets interbedded with freshwater peat and volcanic ash from the past 3000 years. The sheets extend 3 km across the beach-ridge plain, which averages a few meters above sea level. Four or five of the graded sand sheets overlie the volcanic ash Ta-c2 (2000-3000 years old). On the other hand, the long stratigraphic record at Harutori-ko contains evidence for at least 20 tsunamis. This lake or lagoon usually accumulated laminated anoxic mud. Occasionally, however, these conditions were interrupted by punctuating it Holocene history, however, were events that produced beds 0.1-1.0 m thick. A long core 1 km from the modern beach contains such beds that are separated from one another by laminated mud. Some of these event beds grade upward from shell-bearing sand, through mud-clast breccia and laminated silt, into organic mud.