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Tsunami inundation associated with AD 869 Jogan tsunami and fault modeling

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The written history of tsunamis near Sendai begins with a possible predecessor of the 2011 extraordinary large tsunami which was over 1,000 years ago. It is known from series of historical documents (Nihon Sandai Jitsuroku) for the Heian era (AD 794-1192). The documents mention a large earthquake and a tsunami on July 9, AD 869, in the Julian calendar. In these seven years, we carried out geological research to reconstruct inundation area associated with the Jogan tsunami, its predecessors, and theri recurrence intervals.

Tsunami deposits were identified based on litho- and bio-stratigraphy. Tsunami deposits are shown by poorly-sorted and graded sand sheets interbedded with swamp/marsh peat and mud. The sand deposits include many marine and brackish diatoms. They can be traced continuously landward over a few kilometers from the present coast using a key bed of historical volcanic ash (To-a, AD 915), and the distributions are extensively larger than the recent tsunamis (e.g. 1933 Showa Sanriku tsunami, 1960 Chile tsunami, and other 20thcenturyMiyagi-oki tsunamis) and historical and recent storms. These marine-originated, continuous and widespread sand sheets were regarded as tsunami deposits associated with tsunamis.

Radiocarbon ages and tephrochronology can correlate a sand sheet with a tsunami in AD869. deeper part of the cores record that usually large tsunamis repeatedly inundated Miyagi and Fukushima prefecture in the late Holocene. Recurrence intervals were estimated a range between 450-800 years on the basis of a computer program OxCal using radiocarbon ages of samples from 3-4 m geoslicers in Sendai, Yamamoto, and Minami-Soma sites.

Tsunami inundation area was examined by computer simulations. Satake et al. (2008) and Namegaya et al. (2010) tested several types of tsunami source models. They show that tsunami source of the Jogan tsunami was extraordinary larger than usual Miyagioki (off Miyagi prefecture) earthquake (refer Namegaya's presentation in this AOGS meeting).

It requires at least Mw 8.4 (interplate earthquakes with length of 200 km, width of 100 km, upper depth of 15 km or 31 km, and the slip amount of 7 m) to explain tsunami inundation based on distribution of sand sheet. We assumed 14 fault models of the Jogan earthquake (Satake et al., 2008 and Namegaya et al. 2010, ARAFPR). They include outer-rise normal fault, tsunami earthquake, interplate earthquakes with various fault depth, width, length, and slip amounts. In addition, an active fault in Sendai bay is modeled. Tsunami inundation areas in Ishinomaki plain, Sendai plain, and Ukedo river-mouth lowland were computed from these models. The computed areas were compared with the distributions of the Jogan tsunami deposit in each area. As a result, two fault models are selected as possible models; interplate earthquakes with length of 200 km, width of 100 km, upper depth of 15 km or 31 km, and the slip amount of 7 m (Mw 8.4). The 2011 source area includes these source areas, but much wider with larger slip amount.

Keywords: Jogan tsuanmi, tsunami deposit, tsunami model, Japan Trench