Recurrence intervals of large earthquake inferred from tsunami deposit at Idagawa lowland, Minami-Soma city in Fukushima Prefecture.

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Large interplate earthquakes and tsunamis repeatedly occur along the Japan Trench as inferred from historical documents and geological surveys (e.g. Usami, 1996; Utsu, 1999; Tsuji, 2000; Watanabe, 2000). The central Fukushima Prefecture is the southern limit of the distributions of tsunami deposits of the AD 869 Jogan earthquake. Previous studies in Idagawa lowland, Minami-Soma city reported that there were at least three tsunami deposits with normal grading structures and erosional contacts during the recent 2,800 years (Goto and Aoyama, 2005, JpGU; Oikawa et al., 2011, JpGU; Oota and Hoyanagi, 2014, GSJ). Our study site is a polder located about 12 km north of the Fukushima Daiichi Nuclear Power Station.

In this study, we estimate the depositional ages and average recurrence intervals of tsunamis using radiocarbon dating and Bayesian analysis. We analyzed two cores (IDG-02 and IDG-06) of the 13 core samples obtained using the 3 m handy geo-slicer. We found seven tsunami deposits (EV1-EV7) with multiple normal and reverse grading structures, laminas and rip-up clasts (Kusumoto et al., 2016, JpGU; Kusumoto et al., 2016, AGU). The top sand unit (EV1) is distributed on the ground surface and is considered as the 2011 Tohoku tsunami deposit. For the second sand unit (EV2), we distinguished EV2n in IDG-02 core sampled on the north side of Miyata River and EV2s in IDG-06 core sampled on the south side. For AMS ^{14}C dating, we selected terrestrial plant fragments, seeds, woods and charcoals from ordinary deposit and measured 11 samples for IDG-02 core and 14 samples for IDG-06 core. The measured ^{14}C age were calibrated to calendar year using terrestrial calibrated curves IntCal13 of the OxCal version 4.2 program (Bronk Ramsey, 2009; Reimer et al., 2013). The age-depth model was constructed using individual radiocarbon dates, the Poisson-process deposition model and Event Free Depth scale (Fig. 1; Bronk Ramsey, 2008; Ramsey et al., 2012).

For IDG-06 core, the depositional age of EV2s is constrained as 790-1120 calAD based on the 2011 Tohoku tsunami deposit (EV1) and a total of 4 samples between EV2s-EV3. For IDG-02 core, the age of EV2n also ranges from 1100 calAD to 1665 calAD based on the age of EV1 and a plant fragment between EV2n-EV3. The time interval between EV1-EV2s is about 820-1220 years while the interval between EV1-EV2n is about 350-910 years.

The depositional ages of EV3 and EV4 are constrained as 380-530 calAD and 320-470 calAD based on a total of 6 samples between EV2-EV3, a charcoal between EV3-EV4 and 5 samples between EV4-EV5. The time interval between EV2-EV3 is about 350-760 years.

The depositional ages of EV5 and EV6 are constrained as 400-240 calBC and 560-370 calBC based on 2 samples between EV4-EV5, 3 samples between EV5-EV6, respectively. The age of EV7 is estimated as 1210-820 calBC from a total of 5 samples above and below EV7. The time interval between EV5-EV6 is about 330-810 years.

The above results show that the time intervals of tsunami deposits are variable. Time intervals for EV3-EV4 and EV5-EV6 are relatively short, suggesting frequent occurrence, while the intervals for EV1-EV2, EV2-EV3, EV4-EV5 and EV6-EV7 are about 350-820 years, suggesting infrequent occurrence of large earthquakes. The deposit EV2s may correspond to the 869 Jogan earthquake. If that is the case, the time intervals between EV1 and EV2s (1142 years) is much longer than the other intervals.

Keywords: tsunami deposit, AD 869 Jogan tsunami, radiocarbon dating, average recurrence intervals
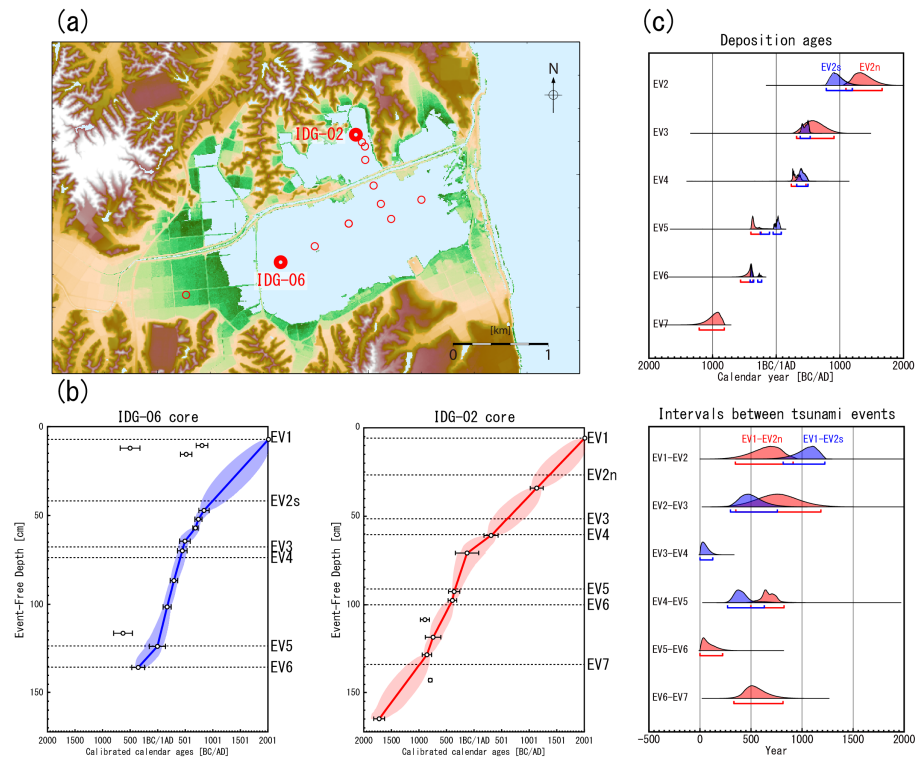

Figure 1. Age-depth relationships for IDG-06 and IDG-02 cores. (a) Topography and sampling sites. (b) The age-depth models for IDG-06 and IDG-02 cores. The circles and bars show the mean values and 2 sigma ranges, respectively. (c) The depositional ages of tsunami deposits and recurrence intervals between tsunami events. Blue color and red color show the results for IDG-06 and for IDG-02 cores, respectively.