Fault model of the unusual AD 869 earthquake off Miyagi, Japan, inferred from tsunami deposits and numerical simulation

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The 869 Jogan earthquake, off Miyagi prefecture along the Japan Trench, produced unusually large tsunamis, according to a historical document and tsunami deposits. One of the oldest official documents in Japan reported that about 1,000 people were drowned from the tsunami in Sendai plain, indicating much larger tsunami than the 1896 Sanriku tsunami (the worst tsunami disaster in Japan caused by a tsunami earthquake) or the 1933 Sanriku tsunami (caused by an outer-rise normal fault event). Our systematic field surveys revealed the distribution of tsunami deposits in Sendai and Ishinomaki plains. In both plains, the 869 tsunami deposits are identified as sand layers just below the regional tephra (To-a from Towada volcano in AD 915). In Sendai plain, the tsunami deposits extend about 1-3 km from the coast line at that time, which is estimated as about 1 km inland of the present coast. In Ishinomaki plain, the tsunami deposits extend more than 3 km from the estimated coast line, which is about 1-1.5 km inland of the present coast. Multiple sand layers indicate recurrence of such unusual tsunamis with approximately 1,000 yr interval. We computed tsunami inundation in both plains from several types of tsunami source models such as outer-rise normal fault, tsunami earthquake (narrow fault near trench axis), interplate earthquakes with fault widths of 50 and 100 km. Comparison of the computed inundation area with the distribution of tsunami deposits indicates that only an interplate earthquake source with 100 km width (top depth of 20 km) and 7 m slip (Mw=8.4) can reproduce the observed distribution of tsunami deposits in both Sendai and Ishinomaki plains. For the deeper source (top depth of 30 km, similar to the 1978 or 2005 Miyagi-oki earthquakes), the slip amount must be as large as 10 m to reproduce the tsunami deposit distribution. A fault model (40 km long and 5 m slip) in Sendai bay produces little inundation in either plain.