The 2008 off-Kamaishi repeating earthquake and micro earthquake activity around the event

Naoki Uchida[1]; Toru Matsuzawa[1]; Tomomi Okada[1]; Kouhei Shimamura[1]; Akira Hasegawa[1]; Kazutoshi Imanishi[2]; William L. Ellsworth[3]

[1] RCPEV, Graduate School of Sci., Tohoku Univ.; [2] GSJ, AIST; [3] USGS

1. Introduction

On January 11, 2008, a M4.7 event occurred at the earthquake cluster that includes M4.9+/-0.1 'characteristic earthquake' off Kamaishi, NE Japan [Matsuzawa et al., 2002, Uchida et al. 2007]. The sequence is characterized by similar sized earthquake on the plate boundary and regular recurrence interval (5.52+/-0.68 year). We precisely estimated source parameters for the earthquakes in the cluster and investigate seismic activity around the M4.7 event.

2. Data and Method

We have relocated earthquakes for the period from 1995 to 2008 by using double-difference method [Waldhauser and Ellsworth, 2000]. We calculated waveform cross-spectra of P and S waves for event pairs to estimate precise travel time differences. The time window was set to be 3.5 seconds starting 1 second before the onset of each phase and delay times were estimated from the phase differences in a frequency band of 1-10 Hz. Note that the obtained 'hypocenter' estimated from this procedure corresponds to the centroid of the slip distribution.

We also estimated source radius and stress drops from corner frequencies assuming a circular crack model. For the estimate of the corner frequencies, the Multi-Window Spectral Ratio method [Imanishi and Ellsworth, 2006] was used for robust measurement of spectral ratios.

3. Results

The centroid of the 2008 off Kamaishi earthquake locates within 70m of 1995 (M5.0) and 2001 (M4.8) earthquakes and the source size for the 2001 event and 2008 event was estimated to be 1094 and 1127m, respectively. Considering the source dimensions and location errors (less than 30m), it is certain that slip areas for recent three earthquakes significantly overlap with each other. Small earthquakes (M3.8 or smaller) near the earthquake were located in three clusters and the centroid of the 2008 M4.7 event was estimated as close as 100m of the middle cluster of the three. A M1.7 earthquake that occurred two days before the 2008 earthquake was also estimated to be inside the slip area for the 2008 earthquake. We also found the small earthquakes tend to have small stress drops (3-11Mpa) compared to the 2001 (41Mpa) and 2008 events (27Mpa).