

Slip properties of earthquakes on the asperity of the M4.9 off Kamaishi repeating earthquake over two earthquake cycles

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We estimated source parameters of interplate earthquakes in the source area of the M4.9 off Kamaishi, NE Japan, repeating earthquakes over two cycles. The M4.9 sequence which composed of 10 earthquakes from 1957 is known for its very periodic occurrence (5.59 \pm 0.67 years) and constant magnitude (M4.9 \pm 0.2) probably due to stable sliding around the source area (asperity). The centroids of three M4.9 mainshock sequence and 50 microearthquakes from 1995 to 2008 were relocated precisely by using double-difference method with differential P and S arrival times estimated from waveform cross-spectra. The source sizes, stress drops and slip amounts for the earthquakes with magnitude 2.4 or larger were also estimated from corner frequencies and seismic moments based on stacked spectrum ratios. The relocation by using double-difference method shows the 2008 M4.9 earthquake is co-located with the 1995 and 2001 M4.9 earthquakes. The comparison of the source parameters for the 2001 and 2008 earthquakes show the seismic moments (1.04 \times 10¹⁶ Nm and 1.12 \times 10¹⁶ Nm for the 2008 and 2001 earthquakes, respectively) and source sizes (radius=570 m and 540 m for the 2008 and 2001 earthquakes, respectively) are comparable. Most of the microearthquakes in the interseismic period are repeatedly occurred in two fault patches near the edge of the source areas for the M4.9 earthquakes. The stress drops for the microearthquakes (3-11 Mpa) are smaller than the 2001 and 2008 M4.9 earthquakes (41 and 27 Mpa, respectively). Two earthquake clusters located near the center of the source areas for the M4.9 earthquakes are inactive compared with others and the timing of these earthquakes is limited in the latter half of the earthquake cycles. Similar spatial and temporal features were seen for other two cycles before the 1995 and 1990 M4.9 earthquakes based on the cluster identification from waveform similarities. We also estimated the hypocenter (rupture initiation point) of the 2008 M4.9 earthquake. Based on careful phase readings and hypocenter relocation by constraining the hypocenters of other small earthquakes to their centroids, we found the hypocenter of the 2008 M4.9 event is located close to its centroid. These results suggest the asperity for the M4.9 earthquake is unfastened progressively from the edge to the center during the interseismic period.

Keywords: off-Kamaishi repeating earthquake, small repeating earthquake, earthquake cycle, asperity, NE Japan, subduction zone