S204-P007 **Room: Poster Session Hall** **Time: May 17**

The 2005 Chiba-ken Hokuseibu earthquake: Source mechanism and strong ground motion

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We determined the source mechanism of the Chiba-ken Hokuseibu earthquake (July 23, 2005) using strong motion records observed by K-NET and ERI. We used the CMT inversion code by Kuge (2003), and Green's functions computed with the 1-D velocity structures derived from the 3-D structures of Yamanaka & Yamada (2003) and Afnimar et al. (2003). According to the result this analysis, the centroid of the earthquake is located at a depth of 70 km (the horizontal location is fixed to the epicenter written in the Unified Hypocenter Catalog), and the mechanism is reverse faulting of NW-SE compression. The depth falls between 73 km by the Unified Hypocenter Catalog and 68 km by F-net, and close to the upper boundary of the subducting Pacific plate. The mechanism is similar to the JMA focal solution from first motion polarities. The observed and synthetic seismograms (displacements filtered with a passband of 0.1 to 0.7 Hz) agree well to each other. The resultant variance reduction of 63.4% indicates good performance for a CMT inversion of middle-band strong motion records. We chose aftershocks immediately after the earthquake until October 27 from the Unified Hypocenter Catalog, and relocated their hypocenters using the code called hypoDD. The vertical cross section of the aftershock distribution suggests a high-angle fault plane dipping to the SEE. This implies that the source fault may not be located on the upper boundary of the Pacific plate. The earthquake may be an in-slab event with a fault plane perpendicular to the boundary. The strong motion record observed at Otemachi, Tokyo looks very similar to those of the M6 events in 1928, 1956 and 1980. This also implies that the earthquake is one of repeating in-slab events, which occur every about 25 years.

We next investigated the attenuation characteristics of peak ground accelerations and peak ground velocities of K-NET, KiK-net and SK-net records with respect to hypocentral distances. The attenuation rate is too large compared to the attenuation curve of Si and Midorikawa (1999) for an in-slab event at a depth of 70 km, but this contradiction can be almost resolved if we apply the correction of Midorikawa and Ohtake (2002) for deep events. However, PGVs larger than the standard attenuation curve are found at distances shorter than 100 km, so that middle-band ground motions were developed in a large zone close to the epicenter around the Tokyo bay. This development is also found in the PGV distribution. Railway companies should check railroads if a PGA larger than 80 gal or an equivalent intensity is observed (JR Research Institute). Since PGAs larger than this value were widely distributed in the PGA map, many trains were suspended for a long time.

An intensity of 5 has been observed in Tokyo 13 years after the previous observation. 5- was observed at reclaimed lands around the Tokyo bay and others. 5- was also observed at inland parts such as Adachi-ku of Tokyo and the southeastern part of Saitama. In particular, 5+ (instrumental intensity 5.0), which is the largest intensity during the earthquake, was observed at Iko in Adachi-ku. On looking at the intensity map northward from the coast of the Tokyo bay, we find 5- at the reclaimed land in Edogawa-ku, then 4 at the sandy delta and coastal lowland, and finally 5- (including 5+) at the wetland (according to the map by Kawamatsu and Matsuoka, 2003). This wetland was formed when the Tone river ran to the Tokyo bay. Intensities 6 and 7 were observed there during the 1923 Kanto earthquake. The overall intensity distribution shows asymmetrical pattern, which is also found in the PGA and PGV distributions. The cause of this asymmetry can be a deep attenuation anomaly (Takeuchi and Furumura, 2005) like that for the 2001 Geiyo earthquake (Koketsu and Furumura, 2002), but we have to consider the effects of soft sediments around the Tokyo bay, because we do not have borehole seismograms for the Chiba-ken Hokuseibu earthquake.