Introduction to the special section for the 2005 West Off Fukuoka Prefecture Earthquake

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On 20 March 2005, the 2005 West Off Fukuoka Prefecture earthquake with Japan Meteorological Agency magnitude (M_{JMA}) of 7.0 occurred in the offshore region of Fukuoka Prefecture, in northern Kyushu, Japan. This earthquake caused more than 1,000 casualties and damaged many buildings in the surrounding area, especially on Genkai Island as well as in and around Fukuoka City.

Because the 2005 West Off Fukuoka Prefecture earthquake was one of the largest intraplate earthquakes in recorder history occurring ages at the junction of the Southwestern Japan Arc and the Ryukyu Arc, intensive seismological and geodetic studies were carried out in its aftermath. Ten papers from these studies were published as the special section for the 2005 West Off Fukuoka Prefecture earthquake (1) of *Earth, Planets and Space*, Vol. 58, No.1, 2006. In addition, eight papers are published in the special section (2) of this issue. These studies have revealed important characteristics of the earthquake as summarized in the following paragraphs.

The mainshock and aftershocks were mainly aligned NW-SE in an approximately 25 km long trend, and the hypocenters of the aftershock region were distributed on a nearly vertical plane at depths of 2–16 km. The mainshock was located near the central part of the aftershock region, with a depth of 9.5 km. These findings suggest that the strike and dip of the fault plane of the earthquake are approximately N60°W and 90°, respectively, and the length and width of the fault are about 25 km and 14 km, respectively. The largest aftershock of M_{JMA} 5.8 occurred near the SE edge of the main aftershock region, and the aftershock region extended about 5 km in the SE direction based on the secondary aftershock activity, which had a different strike angle from that of most of the aftershocks. Following the most intense aftershock activity, there was no distinct enlargement of the aftershock region, and the aftershock activity gradually declined (Shimizu *et al.*, 2006).

The fault structure has been discussed in detail on the basis of precise analyses of aftershock distribution based on onshore and offshore seismic observations made with densely located ocean bottom seismometers (Uehira *et al.*, 2006). The fault plane is bent near both the NW and SE edges: the strike of both edges differs from that of the central part, which includes the hypocenter of the mainshock by 15° in the clockwise direction. T. Matsumoto *et al.* (2006) and Ito *et al.* (2006) determined moment tensor solutions of the mainshock and aftershocks, and both groups found spatial variation of the source mechanisms which corresponded to the fault bending. Uehira *et al.* (2006) showed that the main fault was divided into two segments bordering on the depth of the mainshock. There are 10° differences in both of strike and the dip angles between the lower and upper segments. The geometry of the lower segment was consistent with the focal mechanism solution of the mainshock by P-wave first motions, while the geometry of the upper segment was consistent with the CMT solution of the mainshock (Ito *et al.*, 2006). Thus, the initial rupture probably occurred in the lower segment, followed by the main rupture in the upper segment.

The source process of the mainshock was inferred from strong motion seismograms (Asano and Iwata, 2006; Horikawa, 2006; Suzuki and Iwata, 2006), strong motion and 1-Hz GPS data (Kobayashi *et al.*, 2006), and the coseismic deformation observed by GPS and InSAR (Nishimura *et al.*, 2006). These studies indicated that the rupture of the mainshock started with a relatively small slip and that the maximum slip occurred in the SE of the hypocenter. The maximum slip region, which was regarded as an asperity, is located at a depth of about 2–8 km, close to Genkai Island. The asperity was ruptured at 3.3–3.5 s after the initiation of the rupture (Asano and Iwata, 2006; Horikawa, 2006). Takenaka *et al.* (2006) determined the precise location and the onset timing of the main rupture using the strong motion seismograms, obtaining consistent results with those from the waveform inversions. The source model of the largest aftershock was also estimated from strong motion seismograms (Asano and Iwata, 2006; Suzuki and Iwata, 2006) and strong motion and 1-Hz GPS data (Kobayashi *et al.*, 2006). Furthermore, strong motions were simulated in Fukuoka City (Satoh and Kawase, 2006) and on Genkai Island (Miyake *et al.*, 2006). Satoh and Kawase (2006) calculated the peak ground velocity (PGV) distribution in Fukuoka City, assuming one-dimensional structure models and vertical incident S-waves, and showed that Quaternary sediment mainly contributed to the difference in PGVs inside and outside of the damaged area in Fukuoka City. Miyake *et al.* (2006) simulated broadband ground motions

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during the mainshock on Genkai Island, where no strong motion instruments were in operation, using the aftershock records as empirical Green's functions. The simulation revealed that the ground velocities could exceed 1 m/s with a dominant period of 1–2 s due to the rupture propagation toward the island, which caused serious damage in the island.

Three-dimensional (3D) inhomogeneous structures in and around the focal area have been investigated and discussed in relation to the source process of the mainshock (Hori *et al.*, 2006; S. Matsumoto *et al.*, 2006). Hori *et al.* (2006) estimated 3D velocity structures in and around the source region using double-difference tomography. The results show that high-velocity regions are located at the edge of the aftershock area and on the asperity inferred from the waveform inversion by Asano and Iwata (2006). This implies that the high-velocity regions became either a barrier suppressing the growth of the rupture or an asperity causing the rupture with high stress drop because of the high strength. On the other hand, few aftershocks occur in low-velocity regions shallower than 3 km, implying that the low-velocity regions cannot build up a stress large enough to generate earthquakes because of the low strength. Nakao *et al.* (2006) detected postseismic deformation near the fault using data from a GPS network temporally deployed, revealing that postseismic slips predominantly occurred only in the shallow (less than 3 km) part of the fault, which corresponds to the low velocity regions estimated by the double-difference tomography of Hori *et al.* (2006). S. Matsumoto *et al.* (2006) estimated the spatial distribution of S-wave scatterers using dense seismic array data. The imaging of the scatterer distribution shows that higher strengths are distributed at the SE-extension of the fault plane of the mainshock, which corresponds to the region where the rupture process of the mainshock stopped. Watanabe *et al.* (2006) studied the shear wave polarization anisotropy in and around the focal region. Most of the leading shear wave polarization directions were oriented in the nearly E-W direction, consistent with the maximum compressional stress inferred from the focal mechanism solutions, thus indicating that the observed anisotropy was caused by the stress-induced microcracks. The crack densities were estimated to be about 0.02 in and around the focal region.

Imanishi *et al.* (2006) investigated the off-fault aftershocks that occurred in and around Hakata Bay adjacent to the main fault. Based on their analyses of hypocenter location, focal mechanism solutions, Coulomb failure stress, and stress tensor inversion, they showed that the off-fault earthquakes were the reactivation of a structural boundary. Iio *et al.* (2006) estimated the spatial distribution of static stress drops of the aftershocks and concluded that off-fault aftershocks were generated on very weak pre-existing fault planes based on the finding that stress drops of the off-fault earthquake were relatively small. On the other hand, the stress drops of the aftershocks occurring at the SE end of the aftershock region were large. These results suggest the possibility of a stress concentration at the southeastern edge of the mainshock fault. Furthermore, the stress may concentrate on the NW edge of the Kego fault, which is the southeastward extension of the mainshock fault.

We hope that special sections (1) and (2) for the 2005 West Off Fukuoka Prefecture earthquake will become a milestone towards understanding the mechanism of intraplate earthquakes at the junction of the Southwestern Japan Arc and the Ryukyu Arc, especially in terms of the stress accumulation process for the forthcoming earthquake at the Kego fault.

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