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Overview of the Results of the Metropolitan Project: Regional Characterization of the Crust in Metropolitan Areas for Predicting Strong Ground Motions

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Abstract

A new 5-year project, named "Regional Characterization of the Crust in Metropolitan areas for Predicting Strong Ground Motions," was started in 2003 to characterize sources and propagation paths in Japanese metropolitan areas; the Kanto (Tokyo) region and Kinki (Osaka) region. We conducted three subprograms, 1) Deep Seismic Exploration, 2) Deep Drilling, and 3) Characterization of Earthquake Faults and Crustal Structure, with special emphasis on the characterization of seismic sources. We summarize the purposes of the project, and present results obtained during the first 3-year period.

Key words : strong ground motion, disaster mitigation, controlled source seismology, reflection profiling, urban area

1. Introduction

After the 1995 Kobe earthquake, the Japanese government increased its focus and funding on earthquake hazard evaluations, studies on the integrity of man-made structures, and emergency response planning in major urban centers.

A new agency, the Headquarters for Earthquake Research Promotion, was formed to oversee appropriate research in the earth sciences and civil engineering. Projects covered the following topics: 1) Densification of seismic and GPS networks. 2) Paleoseismological investigation of major active faults. 3) Research on the geometry and physical properties of basins under the cities. 4) Probabilistic strong ground motion estimation. 5) Regional characterization of faults and physical parameters.

2. Regional Characterization Study

A long-term goal of these projects is to produce a map with reliable estimations of strong ground motions. This requires accurate determination of source properties, effects of propagation paths, and near surface ground motion responses. A new 5-year project, named "Regional Characterization of the Crust in Metropolitan areas for Predicting Strong Ground Motions," was started in 2003 to characterize sources and propagation paths in the Kanto (Tokyo) region and the Kinki (Osaka) region. The project is part of the "Special Project for Earthquake Disaster Mitigation in Urban Areas," which consists of three projects besides our projects with the following goals: 1) Significant improvement of the seismic performance of structures 2) Advances in disaster management system, 3) Integration of earthquake disaster mitigation research results.

The proximity of the Pacific and Philippine Sea subducting plates requires studies on the relationships between earthquakes and regional tectonics. This project focuses on identification and geometry of: 1) Source faults, 2) Subducting plates and megathrust faults, 3) Crustal structure, 4) Seismogenic zone, 5) Sedimentary basins, and 6) 3D velocity properties.

Reconstruction of source fault and velocity models allows more realistic 3-dimentional seismic wave simulations. All of these studies will be synthesized and provided to the communities involved in prob-

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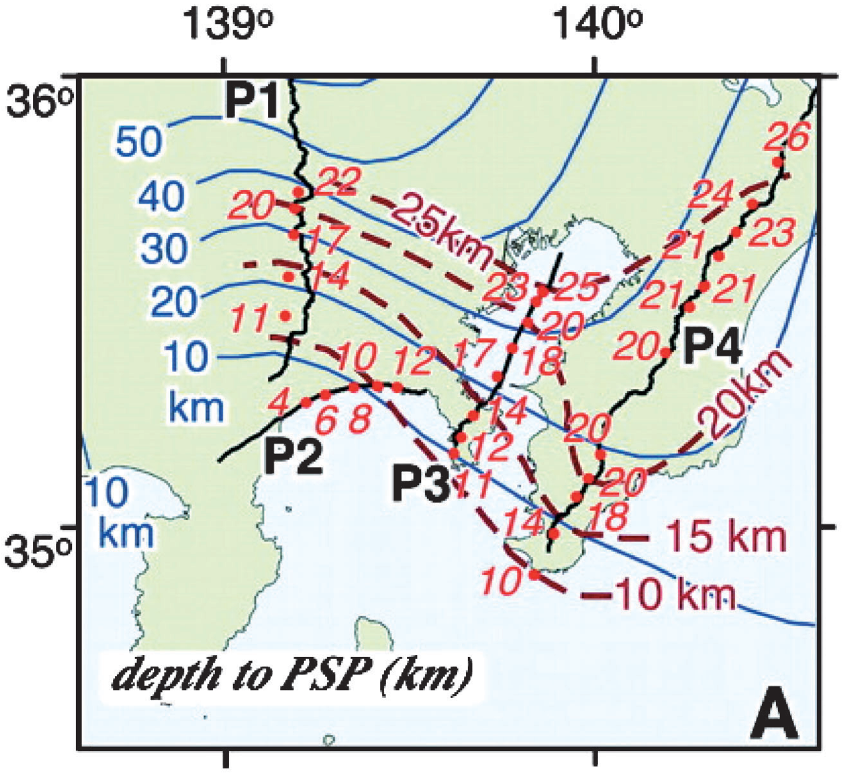

Fig. 1. Depth to PSP in km. Blue contours are from Ishida (1992). Depths from seismic profiles are annotated (red) at marked locations (red dots) and dashed red contours (Sato *et al.*, 2005); note there is a significant mismatch along profiles P1 and northern P3.

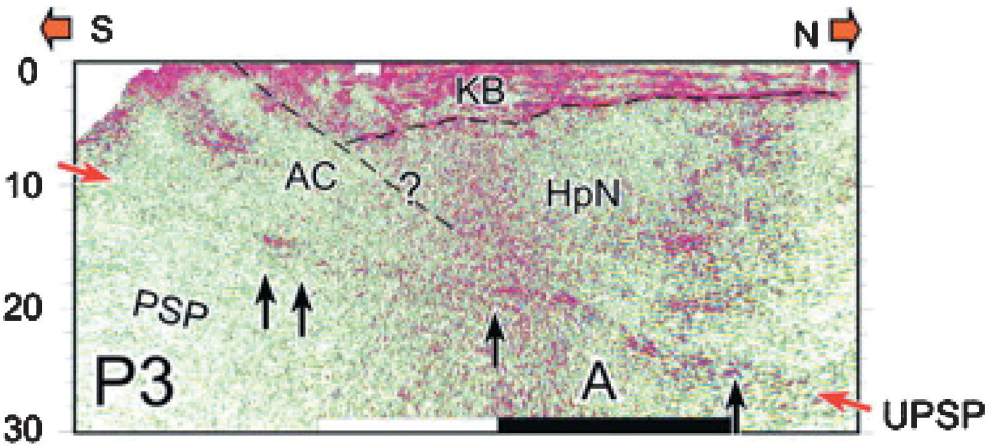

Fig. 2. Seismic reflection profile P3 in the Tokyo metropolitan area. Red arrows denote positions of seismic reflections produced at the upper surface of the Philippine Sea plate. Black arrows delineate clearly visible reflections. Bars at the bottom of the profile indicate lateral presence of strong amplitude (black and 'A'), weak-to no amplitude (white) reflections evaluated by relative amplitude processing.

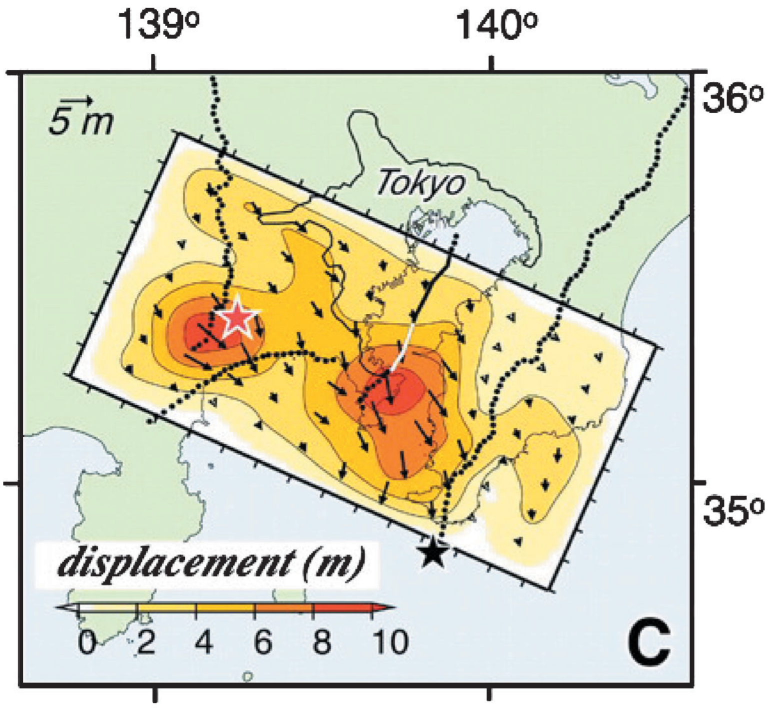

Fig. 3. Slip distribution of the 1923 Kanto earthquake determined by the new plate model (Sato *et al.*, 2005). A white line indicates locations where high reflectivity is observed in the seismic reflection profiling.

abilistic hazards analysis, risk assessment, and societal response.

3. Seismic profiling, drilling, and modeling

The program consists of 1) Deep Seismic Exploration, 2) Deep Drilling, and 3) Characterization of Earthquake Faults and Crustal Structure (Fig. 2).

From 2002 to 2003, we deployed seismic profiling lines on the Boso Peninsula (112 km), the Sagami bay area (75 km), Tokyo Bay (80 km), and the eastern Kanto Mountains to image the source area of interplate earthquakes, such as the 1923 Kanto earthquake, and also intra-plate earthquakes associated with active faults. We drilled two holes in the Boso peninsular and the Sagami bay areas.

Because the Kanto area has high seismic activity, we deployed a linear array of seismic stations on the Boso peninsular to acquire seismic data from regional and teleseismic events.

4. Results

We have obtained good images of the upper boundary of the Philippine Sea plate in the Kanto district, including the source regions of the 1923 Kanto earthquake to make a new model of the Philippine Sea Plate (Fig. 1). The characteristics of reflection signals suggest spatial variations in reflection coefficients, namely, physical properties along the plate boundary (Fig. 2). The reflectivity data are important to locate asperities, where a coseismic slip is large, while inter-seismic coupling is strong (Fig.3). Data from the drilling holes are also interesting for constraining local and regional tectonics at plate boundaries. Natural earthquake data are also acquired to give tomographic images (Fig. 4) and analyze receiver functions of the crust.

Acknowledgments

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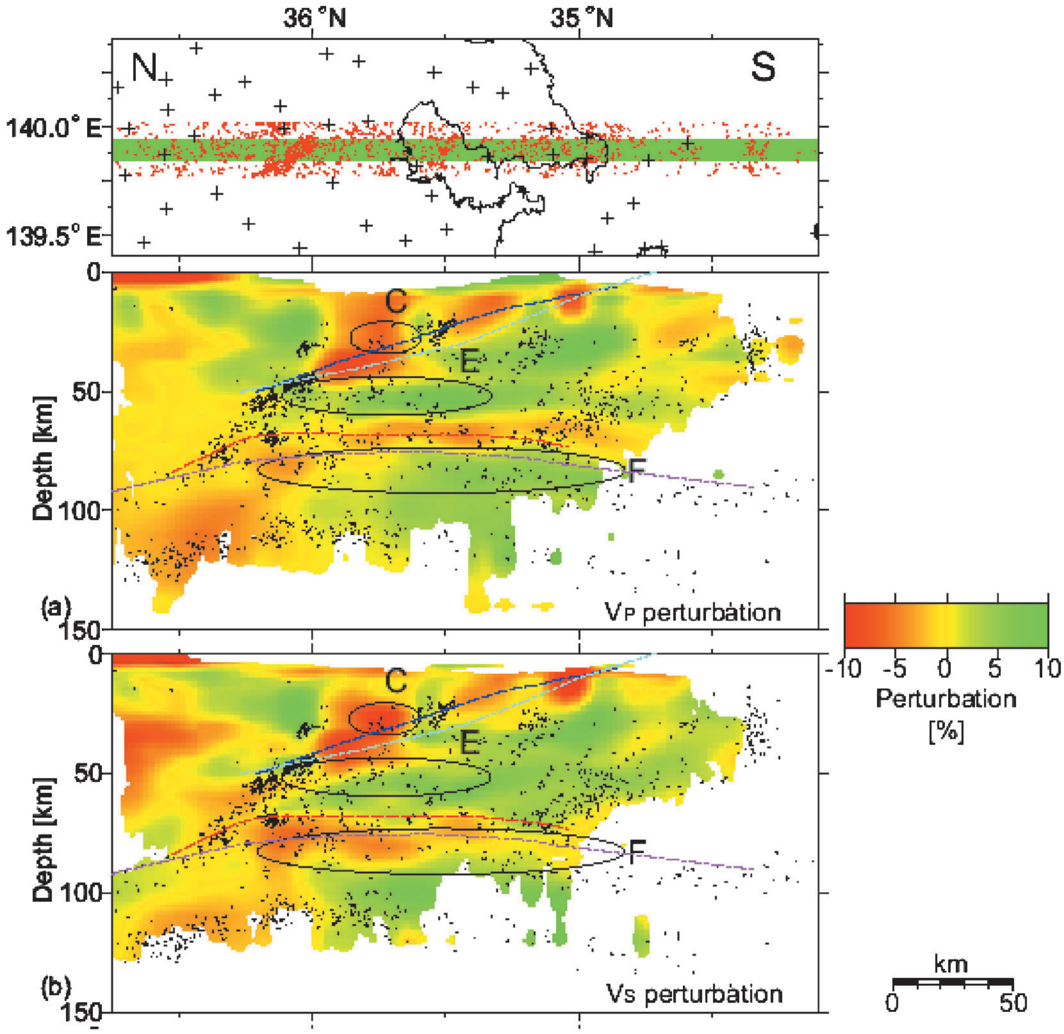

Fig. 4. Vertical cross-sections at 139.9°E (Matsubara *et al.* 2005). (a) Vp perturbation. (b) Vs perturbation. Red and black dots denote earthquakes between 139.85–139.95°E. Dashed blue and red lines denote the geometry of the Philippine Sea and Pacific plates, respectively (Matsubara *et al.*, 2005). Long and short dashed light blue and purple lines denote the configuration of the Philippine Sea and Pacific plates, respectively, as estimated by Ishida [1992]. The area denoted C is interpreted to include up to 30% serpentinized peridotite. Region F, which has high VP/VS, represents the oceanic crust of the PAC plate, while the shallower layer (region E) represents heterogeneity in the PHS plate.

References

Ishida, M. (1992), Geometry and relative motion of the Philippine Sea plate and Pacific plate beneath the Kanto-Tokai district, Japan, J. Geophys. Res., 97, 489–513.

Matsubara, M., H. Hayashi, K. Obara, and K. Kasahara (2005), Low-velocity oceanic crust at the top of the Philippine Sea and Pacific plates beneath the Kanto region, central Japan, imaged by seismic tomography, J. Geophy. Res. 110, B12304, doi: 10.1029/2005JB003673.

Sato, H., N., Hirata, K. Koketsu, D. Okaya, S. Abe, R. Kobayashi, M. Matsubara, T. Iwasaki, T. Ito, T. Ikawa, T. Kawanaka, K. Kasahara, S. Harder (2005), Earthquake Source Fault Beneath Tokyo, Science, 309, 5733, 462–464.

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