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Beginning of precise seafloor positioning near the cable system off Kamaishi

Hiromi Fujimoto[1], Yukihito Osada[2], Satoshi Miura[3], Ryota Hino[4], Minoru Nishino[4], Toshihiko Kanazawa[5], Taichi Kawakami[6]

[1] School of Sci., Tohoku Univ., [2] ERI, Univ. Tokyo, [3] RCPEVE,Tohoku Univ., [4] RCPEV, Tohoku Univ., [5] ERI, Tokyo Univ, [6] KAIYO DENSHI Co., Ltd.

1. Introduction

Recent research works suggest that observation of seafloor crustal movements is critical for the study of seismic coupling at subduction zones. Ueda (2002) examined post-seismic deformations associated with big earthquakes occurred around the northern Japan, and concluded that all the earthquakes were followed by prominent post seismic deformations. While co- and post-seismic crustal deformations of several centimeters were observed on land in the case of 1994 off-Sanriku earthquake, deformation on the seafloor is estimated to be about 20 times (eg., Heki et al., 1997). It is difficult even on land to observe deformations smaller than 1 cm, and seafloor geodesy is crucial.

An ocean bottom cable system is operated off Kamaishi for real-time monitoring of earthquakes and tsunamis. The system has enabled the locating of small earthquakes that occur beneath the seafloor. The most important result of the seismic observation is that the plate boundary off Sanriku is clearly divided into two zones: seismically active zone and inactive zone. A model is proposed to explain the varied seismicity with stuck zones and slipping zones on the plate boundary, but the suggested crustal deformation have not been observed.

2. Deployment of a seafloor positioning system

Graduate School of Science, Tohoku University, and Earthquake Research Institute, University of Tokyo, jointly developed a precise seafloor positioning system. The system is based on precise underwater acoustic positioning combined with sea surface kinematic GPS positioning. We developed a new type of precision acoustic transponders and software for kinematic GPS positioning at a baseline longer than 300 m (Miura et al., 2001).

We deployed three transponders near the cable system about 70 km off Kamaishi in late November 2001 for long-term monitoring of the seafloor deformation. It was a joint work with Iwate Fisheries Technology Center and the deployment was carried out during a 3-day cruise of the Iwate-maru of the center. The seafloor was about 2750m deep on a gentle slope toward the Japan Trench. The seismicity is relatively active in this area. Approximate location of the three transponders (Tokyo Datum):

Unit 1	39	11.800' N,	143	24.390' E,	2700 m
Unit 2	39	09.430' N,	143	26.010' E,	2800 m
Unit 3	39	11.730' N,	143	27.520' E,	2800 m

3. Sea surface observations

We surfaced a small buoy equipped with an acoustic transducer, 3 sets of GPS antennas, and a unit of motion sensor. CTD measurements down to 1000 m were carried out before and after the surface observation with the buoy. In spite of the rough seas, the observation was successful owing to low acoustic noises of the Iwate-maru and skillful operation of the crew. The resolution of the two-way travel time of acoustic signals is preliminarily estimated to be about 1 cm.

We set GPS reference sites at Sendai and Sanriku. Sampling rate was 1 s for both the system on land and at sea. The baseline length for kinematic GPS positioning is about 145 km from Sanriku, and 230km from Sendai. We plan to report the result of the positioning combined with the acoustic measurements.

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