Repeatability of GPS/Acoustic seafloor positioning based on continuous measurements of temperature and pressure in seawater

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Introduction

Observations of seafloor crustal deformation is very important to understand the dynamics of plate boundary that include the strain accumulation processes, great interplate earthquakes mechanisms, and submarine volcanoes activities. We have been developing an observation system with the GPS/Acoustic combination technique for monitoring of seafloor crustal deformation at the Suruga Bay [Tadokoro et al., 2003] and the Kumano Basin [Tadokoro et al., 2004] from 2002 and 2003, respectively. Repeated measurements of seafloor transponder can reveal directly the seafloor crustal deformation in the focal area of the subduction zone.

By using our observation system, we could detect coseismic deformation associated with M7 class offshore earthquakes [Tadokoro et al., 2006]. In addition, repeated observation within one year could detect the velocity of crustal deformation associated with subduction at the both observation areas where huge earthquakes repeatedly occur. However, the both detected deformations were limited in horizontal component. In this presentation, we will report the new seafloor positioning technique for improvement of positioning by using continuous measurement of temperature and pressure in seawater.

Continuous measurement of temperature and pressure in seawater and its purpose

Our seafloor positioning technique can estimate the temporal change of acoustic velocity and the weighted center of three seafloor transponders (we defined this technique as simultaneous estimation technique hereafter). Though simultaneous estimation technique can estimate the three dimensional position, for precise estimation of the temporal change of acoustic velocity, vertical component was fixed in this technique.Due to the reason, we couldn't detect vertical crustal deformation at the both observation areas. For the detection of it, we developed new seafloor positioning technique with constraint for estimation of temporal change of acoustic velocity. The constraint was obtained by the continuous measurement of temperature and pressure in seawater. If we have measurement of temporal change of acoustic velocity, we can estimate the single seafloor position fundamentally. In addition, we can install seafloor geodetic network more effectively than ongoing system.

In parallel with the acoustic measurements, continuous measurements of acoustic velocity conducted by towing the temperature and pressure sensors attached interval of 100 m depth.

Continuous measurements and a result of seafloor positioning

For reduction of the measurement noise, fitting acoustic velocity to smooth surface with ABIC minimization [Murata, 1993] was carried out. This fitted acoustic velocity was used for constraint in the new simultaneous estimation technique. Before applying the actual observed data, we synthesize travel-time dataset and conducted the new simultaneous estimation technique. As a result, standard deviation of weighted center of seafloor transducer was about 1cm. In this presentation, we will report the positioning repeatability of the weighted center by using actual observation data.