GNSS/Acoustic geodetic measurement at the southern end of Ryukyu Trench
- Is great inter-plate earthquake being prepared there? -

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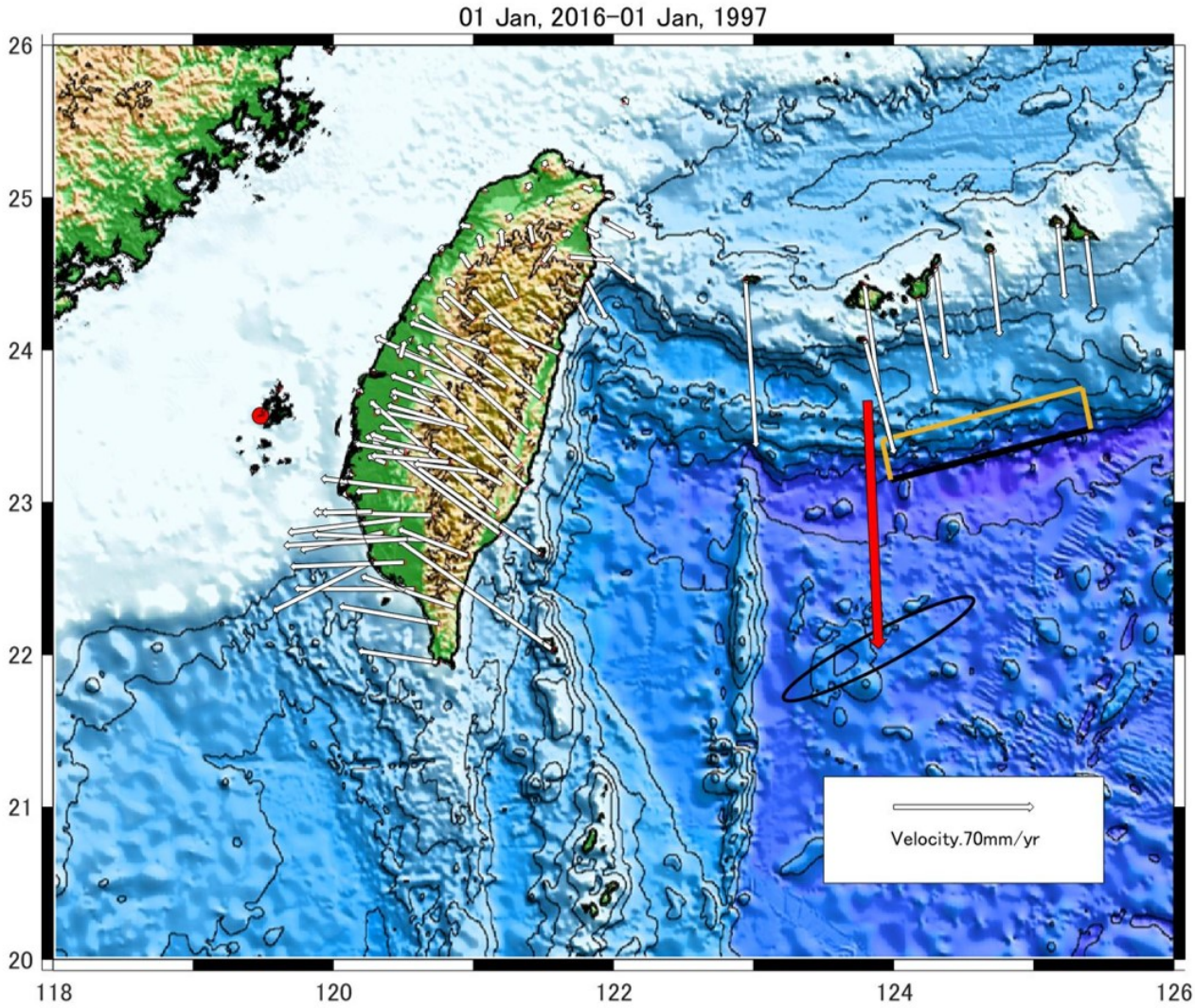
In this presentation, we will show a result of seafloor crustal deformation measurement using GNSS/Acoustic technique conducted south off Hateruma Island in the Yaeyama Islands, from October 2014 to June 2017.
The measurement site is located at the intermediate point between Hateruma Island and trench axis of the Ryukyu Trench which extends from Kyushu to Taiwan. Along the Ryukyu Trench, the Philippine Sea plate subducts north-westward beneath the Eurasian plate at a rate of 8cm/yr around the Yaeyama Islands. Off the north of the Yaeyama Islands, the Okinawa Trough is spreading to the north-south direction at a rate of 4-5cm/yr. The convergence rate between the Philippine Sea plate and the Eurasian plate is thus up to 12.5cm/yr. Scholz and Campos (2012, JGR) suggests that inter-plate coupling in the Ryukyu subduction zone is very weak. However, it is known that Ishigaki, Miyako and the surrounding islands along the southern Ryukyu Trench suffered a significant damage from a large Tsunami in 24 April, 1771. This tsunami is named “Meiwa-Yaeyama Tsunami”. Nakamura (2009, GRL) proposed that the Meiwa-Yaeyama Tsunami was generated by a large tsunami earthquake of Mw8.0 that occurred along the southern Ryukyu Trench. However, Ando et al. (2018, Tectonophysics) conducted a trench excavation survey of tsunami sediment on the coast of Ishigaki Island to find that the earthquake was a great one which generated a strong ground shaking causing cracks on the eastern coast of Ishigaki Island. They also revealed that repeating tsunamis of almost the same size with that in 1771 struck the east coast of Ishigaki Island four times with an average recurrence interval of approximately 600 years in the past 2000 years.
Shizuoka University and Ryukyu University deployed a seafloor benchmark consisting of three seafloor transponders which form a triangle with sides of about 2,100 m at the Ryukyu fore-arc basin where water depth is 3300m. Our aim is to observe the crustal deformation and clarify whether inter-plate coupling exists or not beneath the Ryukyu fore-arc.
The GNSS/Acoustic campaign measurements were conducted four times using observation vessel during three years from October 2014 to June 2017. For each campaign, we obtained 3D coordinate of the onboard GPS antenna and the vessel attitude both with interval of 0.2 sec, a sound speed profile of the ocean, and two-way travel time of the acoustic signals between the onboard transducer and ocean floor transponders. These data are combined and processed using the method proposed by Ikuta et al. (2008, JGR) to solve position of the seafloor benchmark. The 3D coordinate of GPS antenna was solved using IT (Interferometry Trajectory) which is the software suitable especially for long baseline measurement developed by NASA/GSFC. The sound speed profile was measured once in each campaign to represent the sound speed structure at the time. Attitude of the vessel was measured by MEMS-gyro compass IG-500N with attitude accuracy of 0.35deg. The acoustic ranging was conducted from 2,800 to 9,300 times for each campaign. Assuming that sound speed structure changes temporally smoothly, we solved the positions of three transponders by penalized least squares method. To the benchmark positioning

method proposed by Ikuta et al. (2008, JGR), we introduced an additional assumption that the relative position of the three seafloor transponders does not change through all the campaigns. We estimated one relative geometry of the triangle and movement of the centroid for the campaigns (See Chen, Kohmi et al. (2018, GRL) for details).
As a result, the velocity of the centroid is estimated to be southward movement of 11.2±2.4 cm/yr with reference to the Eurasian plate, which is much faster than 5.0 cm/yr of the southward movement at the GEONET site located on Hateruma Island. The result shows that the fore arc basin around our benchmark is stretching to the trench-normal direction. This suggests that there is no or very weak inter-plate coupling at the plate boundary just beneath our seafloor benchmark.
However, the result shows large uncertainty because of the shortness of our observation so that we should continue the measurement to improve the accuracy of the estimated velocity vector. In addition, because we deployed only one seafloor benchmark at the western end of the Nakamura (2009, GRL)’s source region and at 40km north from the trench axis, our measurement can-not deny the possibility of hidden inter-plate coupling at the shallowest part of the accretionary wedge and/or at the eastern extension of our site. Additional survey is required for elucidation of the inter-plate coupling around this region.

Keywords: Yaeyama Tsunami, Ryukyu Trench, GNSS/Acoustic measurement, Seafloor crustal deformation, Inter-plate coupling



The horizontal velocity of geodetic sites.
White arrows show the horizontal velocity of GNSS stations from January 1997 to January 2016 (Red circle shows the reference station). The red arrow shows the velocity of our seafloor benchmark from October 2014 to June 2017. The orange rectangle shows the fault model of the 1771 Yaeyama earthquake(Nakamura 2009).

