Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SCG058-24 Room:302 Time:May 22 18:15-18:30

A slow rifting episode at the Izu back-arc since 2004 September

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Lots of slow slip events (SSE) have been observed at plate convergence margins so far. In the present study, I report that similar events occur at divergent plate margins as slow rifting episodes. East-west tensile stress prevails in the northern part of the Philippine Sea Plate. Behind the volcanic arc of the Izu-Bonin arc, numbers of rift zones composed of north-south trending normal faults develop constituting the Izu back-arc rift zone. Recently, Nishimura (2010) found that the block defined with the three GPS stations in Aogashima, Hachijojima and Mikurajima are moving toward N81E by 6.8 mm/year with respect to the stable part of the Philippine Sea Plate defined by the Daito Islands, Okinotorishima and the Bonin Islands.

While I confirm this result, I found that this eastward movement used to be much slower and has accelerated suddenly in early September 2004. This transient eastward movement is decaying with a time constant of about 4 years, leaving excess eastward cumulative movement up to 3-4 cm in Hachijojima and Aogashima. This acceleration signature becomes faint northward, but is still recognizable in the Miyake and Izu-Oshima Islands.

In 2004 September 5-6, earthquakes occurred in the off southwest Kii Peninsula (M7.2 foreshock, M7.4 Main shock and M6.6 aftershock). Their coseismic deformation is characterized north-south shortening and minor amount of east-west extension (Suito and Ozawa, 2009). The eastward transient movement of the Izu Islands started almost simultaneously with these earthquakes, and appears, at a first glance, postseismic crustal deformation of these earthquakes. However, the afterslip inferred from the movements of GPS stations near to the epicenter. and calculated postseismic crustal movements due to viscoelastic relaxation, are far smaller than the observed transient movements. In fact, the Izu Islands are ˜200 km east of the epicenter. The Muroto GPS station, ˜200 km west of the epicenter, does not show any postseismic movement.

In this study, I hypothesize that the observed eastward transient movements of the Izu Islands are due to the occurrence of a slow rifting episode (SRE) at the Izu back-arc, triggered by the 2004 earthquakes. Because the static stress change by these earthquakes will discourage rifting, it must have been a remote triggering by the passage of seismic waves. After the last rifting episode many years ago, the rift zone has been glued tightly allowing E-W tensile stress to build up. Then the earthquake destroyed the glue for a length exceeding 200 km from Aogashima to Izu-Oshima, making the boundary mechanically free. Then the accumulated stress will be released slowly being balanced with the viscous coupling with underlying asthenosphere, i.e. stress diffusion goes on as suggested by Bott and Dean (1973). By using a realistic value of stress diffusion (Heki et al., 1993), I was able to simulate the SRE in a computer.

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Keywords: GPS, back-arc rifting, Izu-Bonin arc, stress diffusion, rifting episode, slow slip event