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Precursory Strain Rate Changes Before Two Major Intraplate Earthquakes Detected by Continuous GPS Observation

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Precursory crustal deformation preceding a large earthquake has been considered as a key to a successful earthquake prediction, because such phenomena may be properly interpreted with some physical models such as pre-slip. In recent years, numerous highly sensitive deformation sensors, such as borehole strainmeters/tiltmeters, and dense continuous GPS networks, have been deployed worldwide. However, there has been almost no reliable report of precursory crustal deformation of large earthquakes. As Sagiya (2005) raised a question about the famous precursory tilt change before the 1944 Tonankai earthquake, old evidence of such precursory deformation should be reevaluated to the light of modern knowledge. It is crucially important to have reliable such evidences with state-of-the-art observations. We found candidates for such precursory phenomena before two major intraplate earthquakes in the Japan Islands based on the continuous GPS data. The 2000 Western Tottori Earthquake(Mw6.8) occurred in the Chugoku District in western Japan near the Japan Sea coast. According to the continuous GPS observation result, this area has rather small strain rate on the order of 0.01ppm/yr. We calculate strain rate for the triangulation network composed from continuous GPS sites in order to take a look at strain rate distribution in detail. We found that two triangles located at and near the main shock source region had anomalously large(0.3ppm/yr) strain rate before the earthquake. In addition, when we investigate the temporal variation in the strain rate for these triangles, we found that strain rates at those triangles showed a significant decrease starting from about 10 month before the main shock. Similar concentration of large strain and its decrease toward the main shock were also found before the 2004 Mid-Niigata (Chuetsu) Earthquake(Mw6.8). In this case, strain rate decrease started about 4-5 years before the main shock. After the densification of the continuous GPS network in Japan, these two events are the largest ones that occurred just beneath the land whose displacement is monitored by GPS. We are still not quite sure if these phenomena are associated with the occurrence of large earthquakes. But the fact that surrounding triangles do not show such trend implies there is such a possibility. As for the mechanism of generating mechanism of strain rate concentration and decrease, the most probable explanation is done with a pre-slip model. In this interpretation, we consider the preseismic large strain rate is caused by a pre-slip, which occurs at a part of the source fault to release a part of the tectonic stress. However, at the last stage of the preseismic period, pres-lip is suppressed and the strain rate decreases. Then no more stress increment cannot be accommodated by the crustal deformation and finally fault ruptures.