Temporal variation of crustal strain rate in Kinki region, deduced from GEONET data from 1996 to 2004

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In Kinki region, it has been reported that the change of seismicity and strain rate were detected at the beginning of 2003. Tamba-sanchi, which is located at the west of Biwa-lake, is one of the high seismicity regions. However, the occurrence rate of earthquakes clearly decreased since January 2003. Moreover, the change of strain rate was observed by extensometers at Abuyama and Amagase stations deployed by DPRI, Univ. of Kyoto.

The Geographical Survey Institute of Japan (GSI) has deployed continuous GPS observational stations (GEONET) since 1996. We investigated the GEONET data in Kinki region, and we also found a change of horizontal movements at individual stations from the beginning of 2003. Furthermore, a slow event is clearly seen from July to September, 2000. These changes are observed greater at eastern stations rather than at western ones, and start at the same time when slow slip events occur in Tokai region. Therefore, in order to investigate the changes of crustal strain rates in Kinki region associated with such active horizontal movements, we estimated the strain rates by using GEONET data. In this study, we set three periods of time, such as; Mar/1996 to Jun/2000 (Prd I), Jan/2001 to Sep/2002 (Prd II), Apr/2003 to Aug/2004 (Prd III), and estimate strain rates in each stage.

We applied a method by Shen et al. (1996) to estimate distribution of strain rates. In this method, we solve an observational equation that an observed velocity at a GPS station is related with horizontal velocity, strain rates, and a rotation rate at an arbitrary point on the second dimensional plane. We set grid points in Kinki region with every 0.05 degrees, and estimated strain rates at individual calculation points. We used F2 solutions of GEONET data, and estimated each observational velocity by using the time series data composed of daily positions. For the estimation, we removed artificial steps caused by maintenance of antennas at several stations. We summarize the features of the temporal variations of strain rates from Prd I to III as follows.

Areal strain rate: Areal strain rate indicates contractional deformation in the whole of Kinki region. From Prd I to II, the areal strain rate decreases in the almost whole region, it suggests that the contractional deformation is weakened. From Prd II to III, the rate increases in the east of Biwa-lake and Nagoya, although the change of the rate is smaller. Note that the rate in Tamba decreases, it suggests that contractional deformation continues to be weakened.

Principal strain rate: From Prd I to II, contractional component of principal strain rate decreases in most Kinki region. It is remarkable that the rate largely decreases in the east of Biwa-lake, including Yanagase, Yoro, and Neodani faults. Moreover, in around Neodani fault, the contractional axes change from Northwest-Southeast direction to East-West one. In the south of Kii, extentional rates are outstanding in Prd II. From Prd II to III, the change of contractional rate is smaller, but the rate increases in some areas, such as Nagoya. It is noted that the contractional axes in around Nagoya drastically change from northwest-southeast direction to the northeast-southwest one. In Tamba, the rate increases slightly.

Maximum shear strain rate: From Prd I to II, the decrease in the east of Biwa-lake to Nagoya is outstanding. From Prd II to III, the rate increases in around Nagoya.

From our analyses of GEONET data, we found that Tokai slow slip events have strong effects on Kinki region, and they drastically vary strain rates. Our result shows that strain rates decrease in around Tamba, and especially, the areal strain rate keeps decreasing since 2000. Furthermore, it is noted that the strain rates drastically decrease in the east of Biwa-lake, including Yanagase, Yoro, and Neodani faults.