Intraplate Strain Concentration and Large Inland Earthquakes

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The Japanese nationwide continuous GPS network has been contributing to reveal various detailed features of tectonic deformation of the Japan Islands. One of these important findings is discovery of the inland strain concentration zone. GPS observation has revealed that there exists a 50-200km wide belt characterized by large compressive as well as shear strain rate. Within this strain concentration belt, GPS strain rate is over 0.1ppm/year, which is several times larger than surrounding areas. This belt lies along the eastern margin of Japan Sea, the northern Chubu district, and the central Kinki district. Sagiya et al. (2000) named this belt the Niigata-Kobe Tectonic Zone (NKTZ) because the belt connects two recent large inland earthquakes, the 1964 Niigata and the 1995 Kobe earthquakes. Moreover, epicenters of historical large earthquakes are distributed along NKTZ. In addition to the above two events, the 1847 Zenkoji, the 1858 Hietsu, the 1586 Tensho, the 1948 Fukui, the 1891 Nobi, the 1662 Kanbun earthquakes occurred in and around NKTZ. Larger strain rate implies faster stressing rate of the fault, and is consistent with the frequent occurrence of large inland earthquakes. We can expect more inland earthquakes will likely to occur within NKTZ compared with outside in the future. As for the long-term forecast of large earthquakes along NKTZ, seismic gap hypothesis may be applied. Recent the most recent large earthquakes along NKTZ, the 2004 Chuetsu and the 2007 Chuetsu-oki earthquakes occurred filling a seismic gap. Thus the strain concentration zone can be considered as a continuation of weak structure like plate boundaries.

Although the strain concentration itself is apparent, physical mechanism and detailed pattern of strain concentration was not very clear. So an integrated research program has been conducted around the Atotsugawa fault system, central Japan, to answer those questions. The Atotsugawa fault system is a group of ENE-WSW trending right-lateral strike slip faults. We resolved a detailed displacement rate pattern across the fault with accuracy less than 1mm/yr. Among three major faults in the fault system, the Atotsugawa fault is considered to play an important role and have the largest slip deficit of 3-5mm/year, which is consistent with the geologic slip rate. The width of deforming zone around the fault is different for the fault-normal and fault-parallel components. The contraction across the fault distributes more widely. The oblique contraction across the Atotsugawa fault may be partitioned into fault-normal and fault-parallel components and these two components are accommodated in a different manner. Those detailed observation results will provide important constraints on physical mechanism of the crustal deformation and strain concentration.