Strain concentration and its temporal change preceding large inland earthquakes

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Based on the daily coordinate data provided by the continuous GPS network of the Geographical Survey Institute, we have reported that large strain rate was detected around the source regions of the 2000 Western Tottori (Mjma7.3) and the 2004 Central Niigata (Mjma6.8) Earthquakes, and that the large strain rate showed significant decrease toward the occurrence of the main shocks (Nishiwaki and Sagiya, 2005a, 2005b). If such crustal deformation is recognized as a common feature for large inland earthquakes, it may become possible to specify location and time of future large inland earthquakes, which is impossible for now.

In this presentation, we are going to consider two possible generation mechanisms of anomalous crustal deformation before main shocks, i.e., dilatancy and pre-slip. During a compressive deformation of rock, if the compressive stress exceeds some critical value, a dilatancy occurs and the stress-strain relation becomes nonlinear due to the formation of micro-cracks. Preseismic strain rate decrease detected by GPS can be qualitatively explained by such a mechanism. However, the original strain concentration remains unexplained in this case. Motion of crustal fluid is expected in case of dilatancy at the source region. Therefore, we can verify such a possibility through an investigation of ground water changes.

Pre-slip is another candidate for the cause of the anomalous crustal deformation. There had been a swarm-like seismic activity in the close vicinity of the source region of the 2000 earthquake since 1989. In addition, Shibutani et al. (2002) reported that swarm hypocenters and the slip distribution of the main shock are compensatory each other. So it is reasonable to infer preseismic swarm activity is accompanied by pre-slip, and the strain concentration since the beginning of the continuous GPS observation may be also caused by a similar pre-slip. Then we can interpret the decrease of strain rate as a result of a critical state under which no more pre-slip occurs to release the elevated crustal stress. Thus the pre-slip model may explain the intermediate term strain concentration and precursory strain rate decrease in a uniform manner. We will present a result of quantitative modeling effort for two actual cases.