GPS-derived displacement, strain and stress rates in Tokai and Kanto regions

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Earthquake prediction is an important field of research for years, that resulted in some success on long-term and intermediate prediction but short-time prediction is still difficult.Thus, some short term earthquake prediction attemps for Tokai Earthquake in Japan and Parkfield Earthquake in USA have been recently undertaken.

If the stress state and the yielding characteristics of the earth's crust are known at a given time, one may be able to predict earthquakes with the help of some mechanical, numerical and instrumental tools. The stress rates derived from the GPS deformation rates can be effectively used to locate the areas with high seismic risk as proposed by Aydan et al. Thus, daily variations of derived strain-stress rates from dense GPS networks in Japan and USA may provide a high quality data to understand the behaviour of the earth's crust preceding earthquakes.

In this study, an interpolation technique of finite element method proposed by Aydan is used to compute the strain rate and consequently stress rate in the tangential plane to the surface of the earth's crust from crustal deformations in Tokai and Kanto regions of Japan. The stress and strain rates for the area in the close vicinity of the epicentres of anticipated Tokai and Tokyo Bay earthquakes are computed and compared with seismic activity, and their implications are discussed. In addition, the general tendency of deformation pattern obtained from GPS measurements are discussed with that expected from the tectonic models of the regions. Figure 1 shows the GPS points operated by GSI used in the computation between 1997 and 2004. Figure 2 shows the stress variations since 1997 in Suruga Bay, where M8 Tokai earthquake is expected. As noted from the figure, the stress variations are directly correlated with seismicity. The computed strain-stress variations clearly indicated that they tend to increase exponentially before large events such as the 2003 Miyagi-hokubu earthquake (Figure 3). This type behaviour resembles to the tertiary stage in creep tests of geomaterials. Therefore, it is concluded that the GPS derived stress and strain variations may be of great value in earthquake prediction, particularly, of very large events.

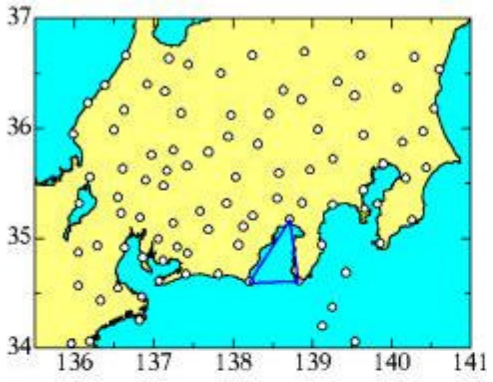

Figure 1

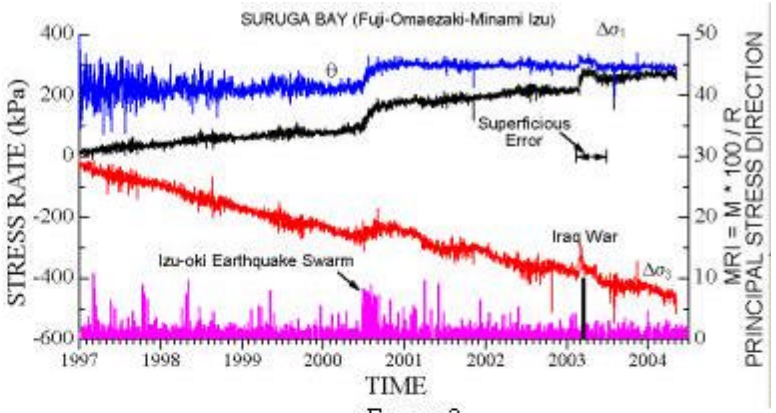

Figure 2

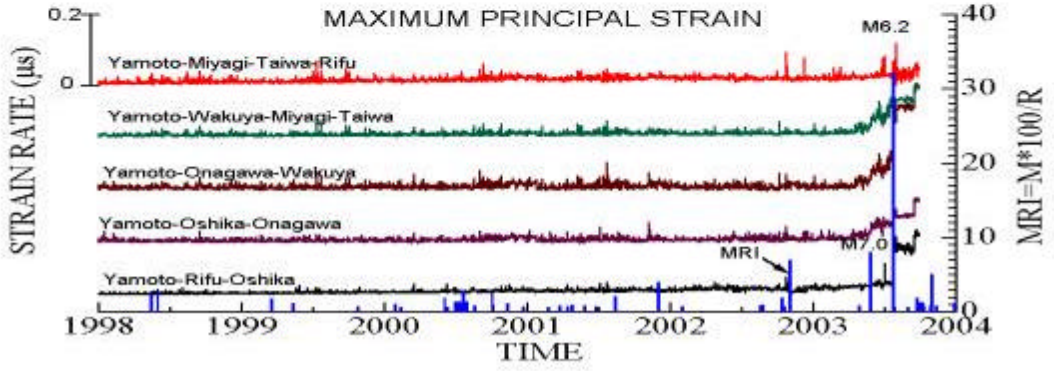

Figure 3