Decrease in stress two days before M=5.5 in the 1989 earthquake swarm of the east off Izu Peninsula.

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The estimation of stress level at seismic source regions is essential to understand physical processes of earthquakes. In laboratory, stress decreases before failure, and the strength increase when the strain rate drastically increases. Though waveform analysis enables us to estimate stress state also for earthquake in ideal cases, there are few works. At gold mines in South Africa, however, the change in physical parameters calculated from seismic moment and seismic energy has been sometimes observed prior to the main event. We therefore applied the method to the 1989 seismic swarm of the east off Izu Peninsula and estimated stress state. The result suggests that the stress level lowered in the vicinity of the source region of the maximum event two days before it.

The estimation of stress level at seismic source regions in Earth's crust, especially prior to the major seismic events, is essential to understand physical processes of earthquakes. In laboratory rock fracture experiments, samples compressed triaxially show inelastic deformation accompanied by stress decrease prior to the main failure; the strength will increase when the strain rate drastically increases. As for earthquakes, however, there are few works to observe such phenomena, because of few means to directly know stress state of source region and far lower strain rate than in laboratory. We can indirectly estimate stress state of source region through seismogram analysis in the limited ideal case that we can obtain enough number of foreshocks and the well estimated all of path and site effects. The seismograms with enough dynamic range and resolution in the vicinity of source region of every seismic event widely ranging in magnitude are required for this kind of analysis. At deep gold mines in South Africa, the observation has been carried out in wide dynamic range and high resolution, and physical parameters (Energy Index and Apparent Volume) calculated from seismic moment and seismic energy have been monitored. They sometimes successfully observe the change in these parameters prior the main seismic event induced by mining, and predict the major seismic events. Their success is also due to much higher rate of stress change induced by mining than that of the source regions of natural earthquakes. The higher rate of strain than the usual crustal deformation were observed in 1989 earthquake swarm of the east off Izu Peninsula due to magma activity and it is interesting to apply the South African method. In the present study, therefore, we analyzed the seismograms of the swarm recorded by NRCDP (NIED at present), and estimated the temporal variation of stress state around the swarm region based on the method used in South Africa. Also we compared the results with the strain and tilt data. As the dynamic range is limited, we only analyzed data that satisfy Gutenberg-Richter relationship and are not clipped; So that we don't need to pay attention to difference in site and path effect, only data at NSI station are used. Taking the attention to the anelastic attenuation, radiation pattern, and fault orientation into account, we estimated Energy Index and Apparent Volume from the seismic moment and the seismic energy. We then obtained the result suggesting that two days before the maximum event (M=5.5) in the swarm activity the stress level decreased in the vicinity of the source region of the maximum earthquake.