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How precise is continuous observation of stress-strain in deep borehole? Examination by invariants of elastic theory.

ISHII, Hiroshi[1*], ASAI, Yasuhiro[1], KAWASAKI, Ichiro[1]

[1]Tono Research Institute of Earthquake Science

Though seismic precursors surely exist, it is considered that they are very small in comparison with coseismic signal caused by the earthquake. However,observations are mostly performed on the surface of the earth where precursory signals are disturbed by the artificial noise and so on ,and may not be able to be detected. One possibility to solve these problems is to make observations in deep underground of bedrock where earthquakes occur.

Being based on this idea we have developed multi-component borehole instrument including multi-component strain meters and stress meters with high sensitivity , tilt meters, seismometers, accelerometers , a thermometer and magnetometers for earthquake prediction study. The sizes of the instrument are about 10 cm of diameter and about 8 m of length depending on purposes and combinations of sensors.

Multi-component borehole instruments have been installed in some boreholes of our observation area. The deepest borehole is 1030m deep. Data obtained by the instruments are send to our institution by online. Our strain meters and stress meters have recorded well strain and stress variations.

In this presentation we report how precise our instruments record stress and strain variations. Our instruments recorded strain and stress seismograms caused by 2011 Tohoku earthquake. By analyzing the records we derived elastic invariants of elastic theory. The invariants derived by several components coincides very well for both one station and different stations. We present the obtained results and discuss goodness of our observation.

Keywords: deep boborehole observation, continuous observation of stress and strain, invariants of elastic theory, observation accuracy, stress seismogram of 3.11 earthquake, multi-component borehole instrument