Environmental effects on strain observation, their applications for geophysical study and necessity of deep borehole observation for noiselessly high quality

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We have been doing tilt and strain observation for both crustal movements and earthquake prediction studies by utilizing observation vaults or deep boreholes. Environmental effects sometimes influence observed data. In this presentation we discuss these effects by focusing on strain observation. Also we will demonstrate that environmental effects as considered to be noise can be usefully utilized for geophysical research.
Results obtained by our research are summarized as follows:

1.Strain observations in vaults are occasionally influenced by rainfall and effects depend on thickness of rock from ceiling of a vault to the surface of the mountain. Sometimes their responses can be successfully simulated by tank model or porous elastic theory. Strain observations in boreholes deeper than depth of 500m hardly are influenced by rainfall.

2.Strain response to rainfall reflects occasionally information on tectonic stress and there are some examples that anomalous strain variations caused by rainfall were related to occurrence of nearby earthquakes.

3.We have been doing continuous crustal movements observation in deep boreholes like 350m, 800m and so on. We have performed some active experiments like water injection and pump up water by means of different boreholes near these boreholes. Behavior of under water and constants related to response of the medium could be determined by these experiments. It is found that active experiments are important for crustal movements study.

4. On processes of studying environmental effects on crustal movements observations, it is clarified that deep borehole observation is necessity for obtaining noiselessly high quality data. By taking into account this, we have developed multi-component borehole instruments that can observe three components of horizontal strain, two components of inclined strain, a vertical strain, two components of tilt, 4 components of geomagnetism, three components of seismic waves and temperature. The multi-component borehole instrument has a size with 6cm to 10 cm of diameter and 150 cm to 500 cm of length depending on how many observation sensors are incorporated in the instrument. The instruments of about 50 were set up in areas with active crustal activities in Japan by some universities and governmental institutes up to now. Most of the instruments were installed in boreholes with depths from 150m to 800m for earthquake prediction observation and have recorded well data.