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# Continuous Observation of Crustal Deformation with a New Borehole Multi-component Instrument

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The significance of in situ long-term observations of the Crustal deformation in the areas of major tectonic activity, which usually cover earthquake-prone regions, in order to study strain build up before earthquakes and its development becomes more and more important.

Deep borehole observation can eliminate effectively various earth's surface interferences, providing considerable advantage over other geophysical measurements made at the ground, and improve greatly our capability to detect very small deformations and vibrations in the surrounding strata. This new technology will promote consequently our understanding of presently active geological processes and its relation to earthquakes and tectonic activities. Based on experiences of developing RZB type borehole strainmeter a new multi-component borehole instrument for deep boreholes has been developed. The new system, namely RZB-3 multi-component borehole observation system consists of down-hole probe, ground instruments including data logger, communication equipment and power supply. The down-hole probe is a complete package comprising of horizontal strain, vertical strain, tilt, strain seismic waves and ground temperature measurement units in a stainless-steel pressure cylinder with 102mm outside diameter and about 5m in length, which can be installed in 150m$\sim$400m deep boreholes with an expansive grout. Arbitrary combination and addition of more sensors are possible. Furthermore, another three subsystems provide the assistant measurements including well temperature, well water level and atmospheric pressure.

Owing to adopting of digital capacitance displacement transducers, which are characterized of low noise, high sensitivity and large dynamic range, the new system can run at maximum sensitivity to provide strain resolution of 0.1nanostrain with the basic dynamic range of $\pm$500microstrain and tilt resolution of 1nanorad with the basic dynamic range of $\pm$500microrad. The total dynamic range can be extended to 4 times larger to satisfy the needs of long-term observations. Up to now the new instruments have been installed at a few sites in Beijing area, Fujian province, Sichuan and Yunnan provinces, and observed clear tidal signals, strain-steps associated with large earthquakes, and other strain changes of geophysical interests. Especially, because of the superiority of the 4-component borehole strain observation, the 4 capacitance displacement transducers mounted on the steel cylinder with 45$^{\circ}$apart, the obtained data show that RZB borehole strainmeter has high measurement accuracy of area strain in Crustal horizontal strain field. The borehole strain meters are calibrated firstly by the manufacturer in a laboratory. They are also calibrated *in-situ* using tidal analysis. The *in-situ* calibration involves comparing the strain changes induced by the earth tides as measured by the instrument with those predicted by theory. Some details related to correction for the observed earth tides and calculation of the area and shear strain were presented, and primary analyses were discussed as well.