

Development of a long baseline laser-extensometer and results of its experimental observation

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We are developing a long-baseline laser-extensometer to observe crustal deformation, especially that due to short-term and long-term slow-slip events. The laser-extensometer is a Michelson interferometer installed in an unused tunnel, Funagira tunnel, in Hamamatsu City. The depth from the ground surface to the tunnel is 160m at most. The baseline length is extended up to 400m in March 2009. Data was obtained in an experimental observation with a 200m baseline extensometer from December 2007 to December 2008.

In an Michelson interferometer, a length change of one wavelength in a 400 meters baseline corresponds to strain of 10^{-9} , which is comparable to resolution of bore-hole-type instruments. We expect to have long-term stability from the long baseline.

We use an iodine-stabilized Ne-Ne laser produced by Neoark. The laser has a stability of 10^{-12} , which is enough to observe a strain change of 10^{-9} . Length change between a beam-splitter and a reflector for the reference beam has a direct effect on the result of the measurement. To reduce effect of thermal expansion, the beam-splitter and the reflector are mounted on a plate made of super-invar. The beam-path is evacuated to a pressure less than 10^{-1} Pa so that the air pressure change would have negligible effect on the length of beam path.

We started a test observation in December 2007. Effect due to rainfall was observed, but it was less than those of multi-component borehole strain-meters in spite of the fact that installation depth is shallower for the laser-extensometer.

Strain change due to a short-term slow-slip event from August to September in 2008 was detected with the laser extensometer. The observed step was 11 nano strain, which was consistent with theoretically expected value.

A preliminary evaluation of the detection level indicated that the laser extensometer would detect the long-term slow-slip events within three months which would be quicker than that with the GPS network.

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