Construction of a laser-strainmeter network for accurate seismic and geodetic observations

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Laser interferometers are widely used for precise measurements of displacement with reference to wavelength of light. As their geophysical application, a laser strainmeter is used for measuring deformation of the ground by sensing distance between two separated points, enabling to detect small strain changes over wide frequency range [1]. The advantages of the laser strainmeter over conventional strainmeters using mechanical references are high resolution with a long baseline, resonance-free response of optical reference, and low-drift detection using stabilized laser wavelength. Apart from the instrumental detectability, local noise sources, such as changes in temperature, air pressure, and ground water level, will affect both the instrument and the ground, and should be properly evaluated to examine the measured strain data. For this purpose, we constructed a network of laser strainmeters deployed at three underground sites in Japan: Kamioka (Gifu Pref.), Inuyama (Aichi Pref.), and Tenryu-Funagira (Shizuoka Pref.). These strain data are analyzed to evaluate performance of instruments installed at these sites as well as to identify common geophysical signals.

At Kamioka site, two laser strainmeters with baselines of 100m and 1500m are in operation [2, 3]. At Inuyama and Tenryu-Funagira sites, a 30-m strainmeter and a 400-m one are installed, respectively [4]. These strainmeters clearly detect earth tides, and their amplitudes are consistent with the calculation based on the tidal force, the standard Earth's model, and the topographic effects around the sites. Using the site effects, coseismic strain steps observed by the strainmeter network are compared with fault parameters estimated from seismic observations and the detectability of the fault mechanisms using the strainmeter network is estimated. For long-term strain changes, local disturbances of the sites and detectability of the network are estimated using GNSS data. In the presentation, we discuss detectability of the strainmeter network for seismic and geodetic signals and prospects for monitoring crustal activities using long-baseline laser strainmeters.

References

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