Data Logging of Dangerous Seismic Events by the Laser Strainmeter and Broadband

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ABSTRACT

Using data laser strainmeter and the broadband seismograph, a part of a seismoaustiko-hydrophysical complex, have been registered large earthquakes of Far East region of Russia and Japan. It has been registered tests of Democratic People's Republic of Korea the nuclear weapon on May, 25th, 2009.

KEY WORDS: Laser strainmeter, nanobarograph, broadband seismograph, microdeformation, earthquake.

INTRODUCTION

Variations of microdeformations of earth crust are caused by internal and external processes. Internal processes are connected with the geodynamic phenomena, seismicity (Dolgikh, 2008). External processes are caused by action of forces periodic and anperiodic character of the next geospheres, atmospheres and hydrospheres. In our article we will consider work of two devices laser strainmeter and a broadband seismograph directed studying of internal processes, namely the dangerous seismic phenomena. It is necessary to notice, that the broadband seismograph allows only data logging earthquakes, explosions and the other phenomena. In view of necessity of reception of exact estimations of size of energy from the seismic phenomena of measurement it is necessary to spend at level of background fluctuations in the wide frequency range, therefore the applied equipment should meet following requirements: high sensitivity and ability to spend measurement in a frequency range from (conditional) 0 Hz. In connection with necessity of carrying out of measurements of sizes from level background fluctuations (bicron) to several centimetres the given equipment should possess big enough dynamic range also. Now the given requirements are answered to the greatest degree with the installations created on the basis of modern lazerno-interferentionsh methods with use is frequency the stabilised lasers. Laser strainmeter allows not only to register these processes, but also to study physics, the nature of the phenomena.

DATA-ACQUISITION EQUIPMENT

Figure 1 shows the schematic diagram of the laser strainmeter. Let us mention the operation of the unequal-arm laser strainmeter. A special-purpose laser with frequency stabilization () is the source of the reference optical radiation with a 0.63-μm wavelength. We used lasers of the Dragun project (based on LGN-303), providing long-term stability of frequency $10^{-10}$ and short-term stability $10^{-11}$. The laser ray arrives at the adjustment optical system (2) containing the beam stretcher and optical shutter. Collimated beam of a diameter of about 7 mm is formed at the output of the stretcher. The optical shutter is an element preventing the entry of the reflected laser radiation into the laser resonator, which can lower the laser frequency stability. Subsequently, the collimated beam comes to the divider that is a plane-parallel glass plate (3). Here, the beam is split into two beams, one of which is directed, through the sealed optical waveguide (4), to the measuring arm of the strainmeter, on the corner reflector (5). The other is projected on to the system of mirrors (6) and (7). The reflected beams are gathered on the plane-parallel plate (3), and the resulting interference picture (IP) gets into the registering photodiode (8). Mirror (6) is attached on a piezoceramic cylinder, which is under an alternating service voltage of the frequency of 25 kHz; the voltage is necessary to work the registering system. The control voltage is fed to the other piezoceramic element (7). Its instantaneous value is such that the variation in the optical path of the ray in the reference arm, caused by change in the length of the ceramic element under the control voltage, compensates variation in the length of the measuring arm. It is natural that the range of extension or compression of the piezoceramic element is insufficient for tracing an appreciable displacement. The use of an electronic "level drop" method eliminates this problem and expands the dynamic range of the laser strainmeter in the frequency range concerned. The essence of the level drop is as follows: as variation in the length of the measuring arm interferometer (because deformation of the crust) reaches one half the wavelength of the reference laser radiation, corresponding to the displacement of the resultant interference picture by one order of magnitude, the control voltage vanishes. The limiting control voltage at which the drop occurs was determined by one order of magnitude. The measured value is the electric signal proportional to the control voltage. The instrument is readily calibrated and possesses good reproducibility. Since the frequency-stabilized laser is used, the value of the drop always corresponds to variation in the length of the measuring arm of the laser strainmeter in wavelength fractions of the reference optical radiation.