Borehole Array observation system operated by Tono Research Institute of Earthquake Science, ADEP and Some Interesting Results

Yasuhiro ASAI (E-mail: asai@tries.jp), Hiroshi ISHII, Makoto OKUBO, and Harumi AOKI
Tono Research Institute of Earthquake Science, Association for the Development of Earthquake Prediction

Deep boreholes (deeper than about 500m) enable the high S/N ratio observations for detecting very small signals without artificial noises and meteorological disturbances. But the cost of digging deep borehole is too expensive. Therefore, in order to bring cost down per a sensor, we have developed multi-component borehole instruments (Figure 1) for deeper boreholes than about 1 km (e.g. Figure 2) with smaller diameters than 98 mm.

The newest instrument is composed of 6 strainmeters (4 horizontal and 2 vertical), 2 tiltmeters, 3 seismometers, 3 magnetometers, 1 thermometer, and A/D conversion unit for each sensor; arbitrary combination and addition of more sensors are possible. We use the 16 bit SAR (successive approximate register) A/D converter. The original sampling interval for each sensor is 9.6 kHz. The dynamic ranges for seismometers and others are improved 21 bits and 24 bits from 16 bits by averaging the 17 and 129 sampling data, respectively. Frequency responses of the observation system are not spoiled by this procedure, because averaging numbers are determined in consideration of final sampling rates. Final sampling rates are 400 Hz for seismometers, 40 Hz for strainmeters and tiltmeters, and 20 Hz for magnetometers and thermometer, respectively. Data obtained from each record are transmitted to a surface by using only one coaxial cable. Before installation of the multi-component borehole instrument, we install a wireless intelligent type strainmeter at the bottom of the borehole, and perform in-situ stress measurement by using the overcoring method. And then we install the multi-component borehole instrument at the bottom of the deep boreholes with expansion grout.

The multi-component borehole instruments were installed at the bottom of the seven deep borehole sites in Tono region, central Japan. These observation sites form the borehole array observation system with approximately 10 km in length and in WNW-ESE direction (Figure 3). The deepest borehole (JRJ) is 1030m and the second (BYB) is 1020m. Up to the present, this array system has observed the good tidal signals, strain-steps associated with large earthquakes, and remarkable strain changes associated with the activity of non-volcanic deep low-frequency tremors in the Tokai district, central Japan. We will present the details of our borehole array observation system and above-mentioned results obtained from the borehole observations.

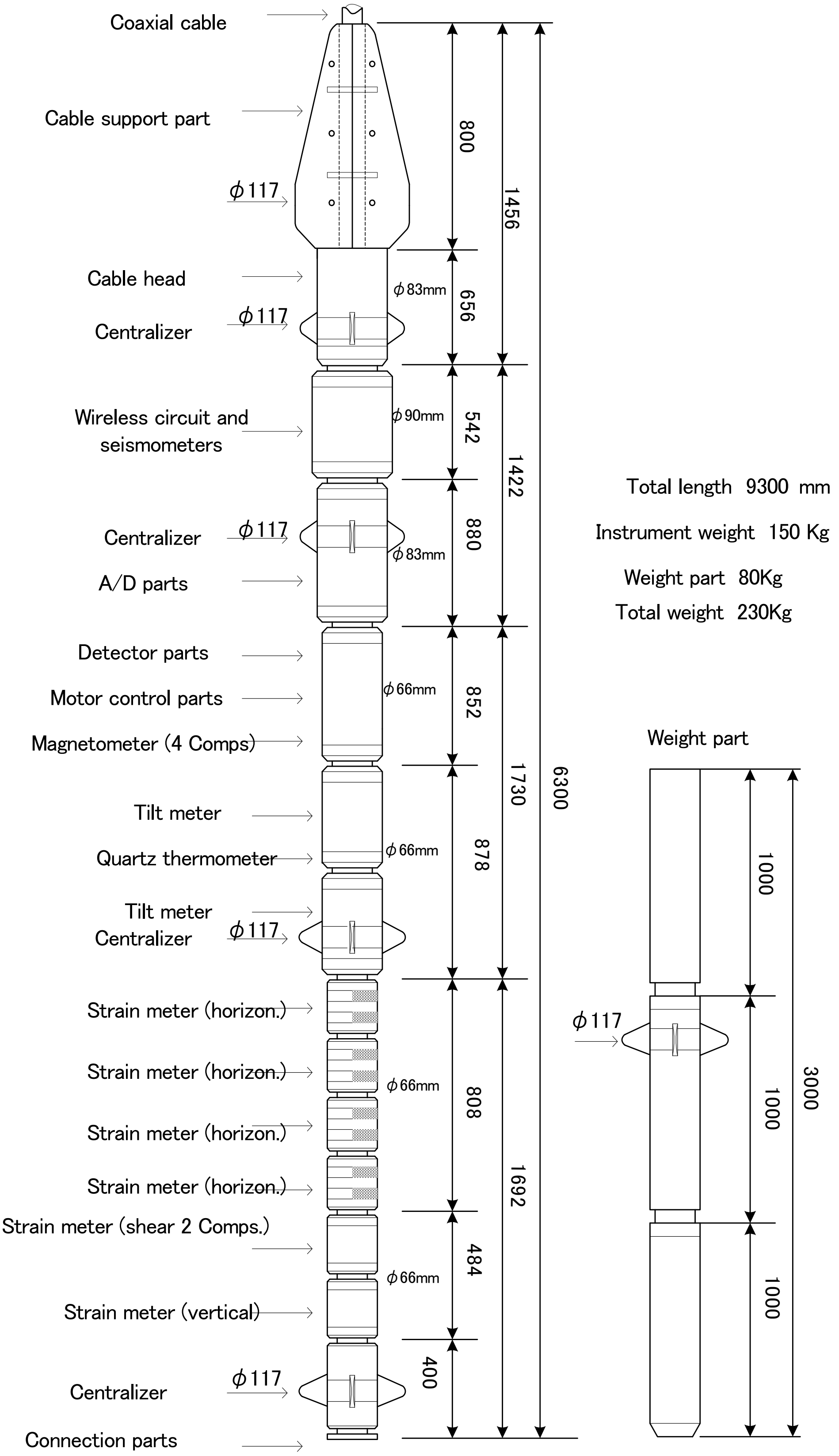

Figure 1. A small diameter Multi-component instrument for crustal activity employed for JRJ.

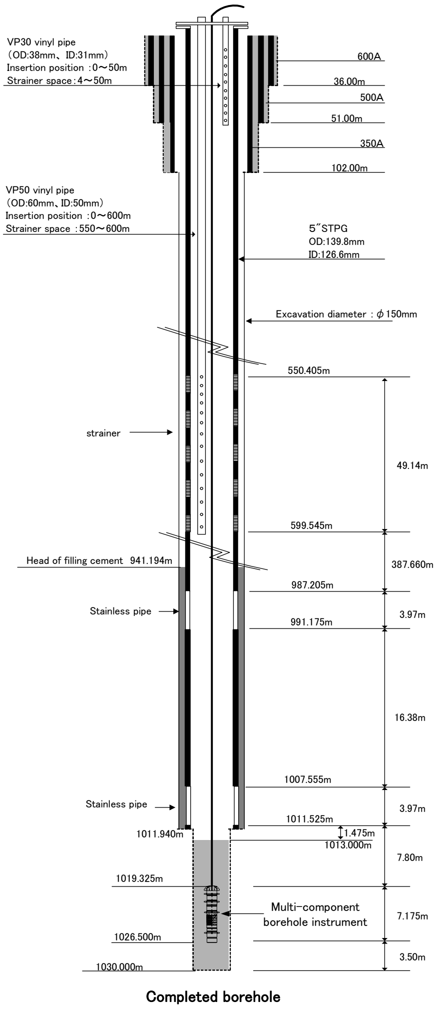

Figure 2. Structure of borehole for Jorinji station (JRJ; 1030m depth).

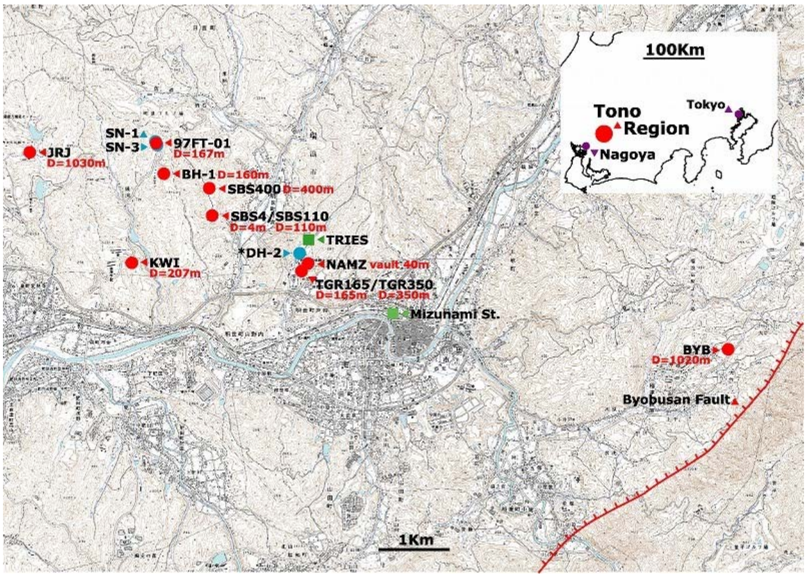

Figure 3. Borehole array observation system operated by TRIES. Red numerals indicate depth of borehole.